This public summary represents information presented in the document. Neither the document nor the public summary has been reviewed by the regulatory agencies.

Public Summary: **Field Sampling Plan and Quality Assurance Project Plan**
Phase III Groundwater Data Gaps Investigation
Hunters Point Shipyard, San Francisco, California

This document summarizes the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) for the Phase III Groundwater Data Gaps Investigation (GDGI) at Hunters Point Shipyard (HPS) in San Francisco, California. The GDGI was undertaken to obtain additional data to help evaluate potential remediation technologies for groundwater at Parcels C, D, and E. The Phase III GDGI is the third and final stage. Data collected during Phase III of the GDGI will be presented in information packages that will be specific to each parcel. The intent of the information packages is to provide a basis for evaluation of groundwater data for use in revised feasibility study (FS) reports for Parcels C, D, and E.

Background: The U.S. Department of the Navy initiated a basewide GDGI in Spring 2000 to obtain an updated assessment of groundwater conditions at HPS. The study was needed to supplement information that was gathered during the remedial investigations conducted during the early to mid-1990s. The updated information will be used to help evaluate remediation technologies for groundwater in the revised FS reports for Parcels C, D, and E.

A Phase I field investigation was conducted from August to December 2000 and included a basewide well inspection, a basewide water level measurement effort at about 200 monitoring wells, installation of more than 30 new monitoring wells in Parcels C and D, and groundwater sampling in Parcels C and D. A Phase II field investigation was conducted from January to April 2001 and included a basewide water level measurement effort at more than 300 monitoring wells and groundwater sampling in Parcels C, D, and E.

Phase III GDGI: The Phase III GDGI will be conducted in Spring 2002 and will be made up of six primary tasks:

- Measure water levels basewide to evaluate the patterns of groundwater flow in the shallow and deep aquifers, known as the A-aquifer and B-aquifers
- Further characterize the B-aquifer in Parcels C and E by sampling existing and newly installed wells for hydrogeological and chemical analysis
- Sample existing wells in the A-aquifer and bedrock water-bearing zone in Parcels C, D, and E for chemical analysis to confirm the extent of contamination at areas of concern in groundwater
- Conduct hydraulic tests in Parcels C and E to assess hydrogeologic parameters of the A-aquifer and the degree of hydraulic connection between the A- and B-aquifers and the bedrock water-bearing zone
- Study the extent of tidal influence and mixing at Parcels C, D, and E
- Sample existing A-aquifer wells in Parcels C, D, and E for analysis of radiological constituents to support the basewide radiological data gaps study

The Phase III GDGI has been modified from the previous phases of the investigation based on data collected recently and on comments from the regulatory agencies and the public. The significant changes of interest from the Phase II investigation to the Phase III investigation are:

- Characterization of groundwater in Parcel D is limited to the A-aquifer at Installation Restoration (IR) site 22.
- Hydraulic tests will be conducted in four locations in Parcel C and two locations in Parcel E.
- Tidal influence and the tidal mixing zone may be studied in Parcels C, D, and E.
- Twelve additional wells will be sampled in IR-06.
- Twenty additional wells will be sampled for standard analytes in groundwater at a landfill in IR-01/21.
- Analysis for radiological constituents will be added to samples from 31 wells in Parcels C, D, and E. A background evaluation will be conducted at five wells in Parcels B, C, D, and E.
- New monitoring wells will be installed in Parcels C and E for supplemental groundwater characterization, hydraulic testing, tidal studies, and replacement of decommissioned wells.
- Sampling for analysis of monitored natural attenuation parameters is eliminated from 75 of 175 wells in Parcels C and E.

Next Steps: The data from Phases I, II, and III will be evaluated jointly, and the results will be summarized in a document scheduled for release in Summer 2002. The Navy will use the results of the GDGI to help prepare revised FS reports that evaluate remedial technologies and alternatives for groundwater in Parcels C, D, and E.

Information Repositories: A complete copy of the FSP and QAPP for the Phase III GDGI is available to members of the community at:

San Francisco Main Library
100 Larkin Street
Government Information Center, 5th Floor
San Francisco, CA 94102
Phone: (415) 557-4500

Anna E. Waden Library
5075 Third Street
San Francisco, CA 94124
Phone: (415) 715-4100

The package is also available to community members on request to the Navy. For more information about environmental investigation and cleanup at HPS, contact Mr. Keith Forman of the Navy at (619) 532-0786 (phone), (619) 532-0995 (fax), or mailto:formanks@efdsw.navfac.navy.mil (e-mail).

Comprehensive Long-Term Environmental Action Navy (CLEAN II)

Contract # N62474-94-D-7609 · Contract Task Order 0011

Field Sampling Plan and Quality Assurance Project Plan Addenda for the Phase III Groundwater Data Gaps Investigation

Hunters Point Shipyard
San Francisco, California

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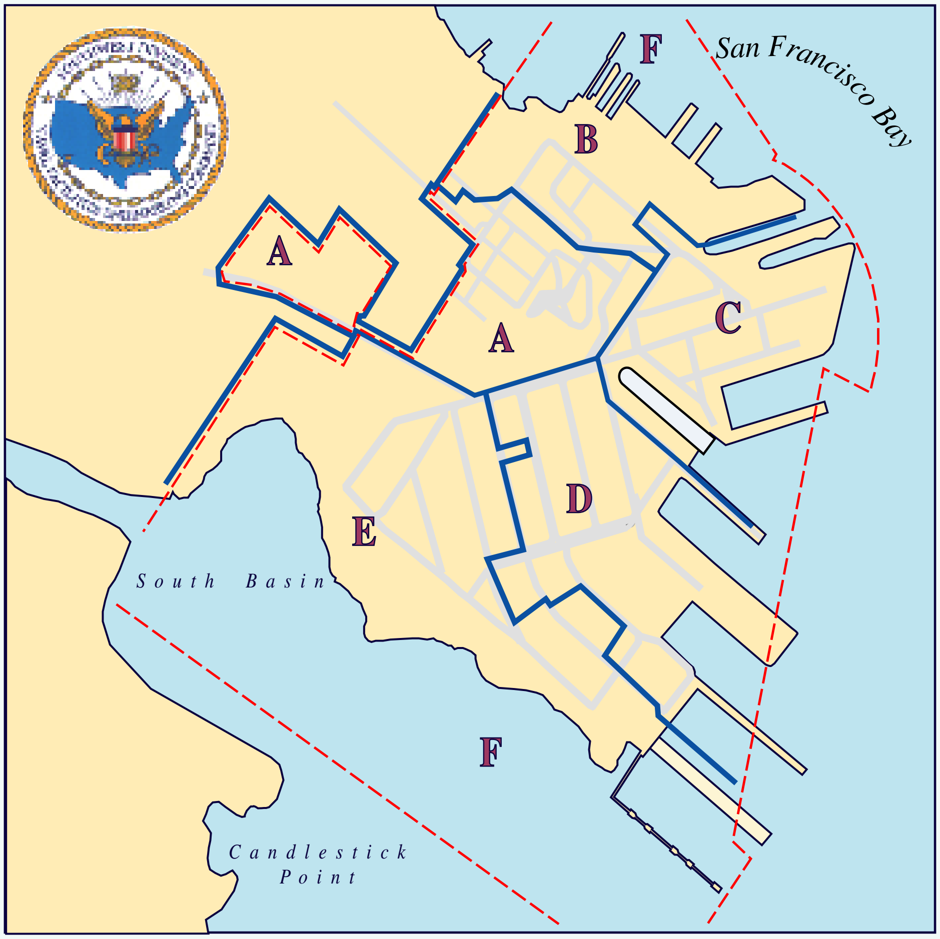

February 5, 2002

Department of the Navy • Southwest Division

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Order 011

Prepared for

U.S. DEPARTMENT OF THE NAVY

Southwest Division
Naval Facilities Engineering Command
San Diego, California

FIELD SAMPLING PLAN ADDENDUM FOR PHASE III GROUNDWATER DATA GAPS INVESTIGATION (ADDENDUM II) HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

DS.0011.17267

February 5, 2002

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COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
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FIELD SAMPLING PLAN ADDENDUM
FOR
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
(ADDENDUM II)
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Prepared for:

U.S. DEPARTMENT OF THE NAVY

REVIEW AND APPROVALS

TtEMI Program
Quality Assurance Manager: ______ for Date: 1/31/02
Gregory Swanson
TtEMI San Diego

Navy Quality Assurance Officer: ______ Date: 1/31/02
Narciso Ancog

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ABBREVIATIONS AND ACRONYMS

API	American Petroleum Institute
ARCH	Air rotary casing hammer
ASTM	American Society for Testing and Materials
BCT	Base Realignment and Closure Cleanup Team
bgs	Below ground surface
BRAC	Base Realignment and Closure
CLEAN II	Comprehensive Long-term Environmental Action Navy
CTO	Contract Task Order
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
FS	Feasibility study
FSP	Field sampling plan
GDGI	Groundwater data gaps investigation
HCl	Hydrochloric acid
HPS	Hunters Point Shipyard
HSA	Hollow stem auger
HSP	Health and safety plan
ID	Identification
IR	Installation Restoration
MNA	Monitored natural attenuation
mg/L	Milligram per liter
Navy	U.S. Department of the Navy
NOAA	National Oceanic and Atmospheric Administration
PCB	Polychlorinated biphenyl
POC	Point of compliance
PRC	PRC Environmental Management, Inc.
PVC	Polyvinyl chloride
QAPP	Quality assurance project plan
QC	Quality control
RI	Remedial investigation
RU	Remedial unit

ABBREVIATIONS AND ACRONYMS (Continued)

SOP	Standard operating procedure
SVOC	Semivolatile organic compound
TDS	Total dissolved solids
TIZ	Tidally influenced zone
TSS	Total suspended solids
TtEMI	Tetra Tech EM Inc.
VOC	Volatile organic compound

1.0 INTRODUCTION

Tetra Tech EM Inc. (TtEMI) received Contract Task Order (CTO) Nos. 005 and 011 under Comprehensive Long-term Environmental Action Navy Contract No. N62474-94-D-7609 (CLEAN II) from the U.S. Department of the Navy (Navy), Naval Facilities Engineering Command, Southwest Division, to conduct a remedial investigation (RI) and continue through record-of-decision activities at Parcels D and E (CTO 005) and Parcels B and C (CTO 011) at Hunters Point Shipyard (HPS), San Francisco, California. TtEMI received subsequent modifications to CTOs 005 and 011 to evaluate data gaps for groundwater.

A phased approach is being used to implement the current groundwater data gaps investigation (GDGI). The Phase I GDGI was conducted at Parcels C and D at HPS from July 2000 to December 2000. The Phase I GDGI was conducted in accordance with the associated planning document, "Final Field Sampling Plan [FSP] and Quality Assurance Project Plan [QAPP] for Phase I Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California," dated July 31, 2000 (TtEMI 2000a; also see Appendix A of this FSP addendum). The results of the Phase I GDGI were summarized in "Information Package for the Phase I Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California," dated December 1, 2000 (TtEMI 2000c). A revised Phase I GDGI information package was submitted on January 8, 2001 (TtEMI 2001b) to address concerns discussed during a December 5, 2000, working meeting (Navy 2000).

The Phase II GDGI was conducted at Parcels C, D, and E at HPS from January 2001 to April 2001. The Phase II GDGI was conducted in accordance with the associated planning document, "Field Sampling Plan and Quality Assurance Project Plan Addenda for Phase II Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California," dated January 8, 2001 (TtEMI 2001a; also see Appendix B of this FSP addendum). The results from the Phase II GDGI were summarized in three documents:

- "Parcel D Information Package Phase II Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California," dated June 1, 2001 (TtEMI 2001c)
- "Parcel C Information Package Phase II Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California," dated August 3, 2001 (TtEMI 2001d)
- "Parcel E Information Package Phase II Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California," dated August 10, 2001 (TtEMI 2001e)

This FSP addendum is a supplement to the final Phase I GDGI FSP/QAPP (TtEMI 2000a) (also see Appendix A of this FSP addendum) and to the Phase II GDGI FSP/QAPP (TtEMI 2001a) (also see Appendix B of this FSP addendum). All changes in the Phase I and Phase II GDGI statement of work for the Phase III GDGI are set forth in detail in this FSP addendum. However, for brevity, sections of the FSP for the Phase I and Phase II GDGI with no changes are not included in this FSP addendum. Instead, those sections are noted herein as having "no change." Table 1-1 summarizes significant changes in this FSP addendum.

This FSP addendum (and the FSP for the Phase I and Phase II GDGIs) provides specific details about the methods to be used for sample collection, sampling locations, number of samples to be collected, field quality control (QC) procedures, sampling and handling procedures, and shipping. A QAPP addendum has also been developed to supplement this document. The QAPP addendum (and the QAPP for the Phase I and Phase II GDGI) fully describes the data quality objectives (DQO) for the project, which have been developed through the seven-step DQO process (U.S. Environmental Protection Agency [EPA] 2000a) in accordance with EPA guidance for preparation of QAPPs (EPA 1998). This FSP addendum and the accompanying QAPP addendum make up the sampling and analysis plan addendum. Both documents are provided in a single binder for easy reference. Field crews are required to have hard copies of the FSP and QAPP for the Phase I, II, and III GDGIs on hand at all times. A summary of the site background and the results of previous investigations are presented in the accompanying QAPP. A more detailed discussion of background and an analysis of site information are presented in the RI reports for Parcels B, C, D, and E (PRC Environmental Management, Inc. [PRC] 1996a, 1997a, 1996b, 1997b, respectively) and the feasibility study (FS) reports (PRC 1996c, 1997c; TtEMI 1998a, 1998b). Data collection and measurement activities set forth in detail in this FSP addendum will be conducted in accordance with TtEMI's "CLEAN II Program Health and Safety Plan [HSP], Revision I" (PRC 1995) and the basewide HSP (TtEMI 2000b).

Section 2.0 of this FSP addendum describes the purpose and objectives of the investigation. Section 3.0 provides information about the site location and background. Section 4.0 provides specific details about proposed field methods and field procedures. Section 5.0 presents the procedures to be used in collecting and handling field quality assurance and QC samples. Section 6.0 provides procedures for handling and shipping samples and chain of custody. Section 7.0 outlines the health and safety concerns and requirements for the investigation and provides references to the basewide HSP. Section 8.0 presents the schedule for the Phase III GDGI. Section 9.0 summarizes reporting of the Phase III GDGI results. Section 10.0 lists all references cited in this document. Tables, figures, and appendices are presented after the text.

2.0 PURPOSE AND OBJECTIVES

The purpose and objectives of this investigation, as well as the chronology of events that led to the Phase III GDGI, are more fully described in the accompanying QAPP addendum. The overall project objective of the GDGI is to resolve the following data gaps: (1) the most current basewide map of the potentiometric surface for the A-aquifer was generated more than 4 years ago and therefore may not reflect current groundwater flow conditions; (2) the extent of contamination in the B-aquifer and its relationship to the A-aquifer at Parcels C and E have not been adequately evaluated because chemical and hydrogeologic data are insufficient to support a full evaluation; (3) the nature and extent of groundwater contamination in the A-aquifer and bedrock water-bearing zone at Parcels C, D, and E were characterized using chemical data collected more than 4 years ago; (4) hydrogeological data for the A-aquifer are insufficient to evaluate potential remedial alternatives, and the degree of hydrogeological connection between the A-aquifer, B-aquifer and bedrock water-bearing zone cannot be quantified using existing data; (5) flow patterns for shallow groundwater near the shoreline are not well understood; and (6) shallow groundwater has not been evaluated for radionuclide contamination, that may be a result of site-related activities. The data gaps for groundwater have been identified at Parcels C, D, and E based on the results of working meetings with the Base Realignment and Closure (BRAC) Cleanup Team (BCT).

The specific purpose of this FSP is to describe the following six discrete tasks that will be completed under the Phase III GDGI to address the data gaps listed above:

1. Measure basewide water levels to construct a groundwater potentiometric surface map from data collected at existing A- and B-aquifer wells.

2. Further characterize potential groundwater contamination in the B-aquifer in Parcels C, and E by sampling existing and newly installed wells, and evaluating hydrogeologic parameters (including yield, hydraulic conductivity, horizontal gradient, and vertical gradient).

3. Further characterize the nature and extent of contamination by resampling A-aquifer and bedrock water-bearing zone wells in Parcels C, D, and E for analysis of chemical parameters.

4. Conduct hydraulic tests at four A-aquifer wells in Parcel C and two A-aquifer wells in Parcel E to assess hydrogeologic parameters of the A-aquifer and the degree of hydraulic connection between the A- and B-aquifers and bedrock water-bearing zone.

5. Collect continuous water level and electrical conductivity data using transducers from shallow groundwater monitoring wells in the zone of tidal influence.

6. Collect two rounds of groundwater sampling for 36 monitoring wells included in the data gaps study of radionuclides in shallow groundwater at HPS.

Tasks 2 and 3 will additionally include collection of data on total dissolved solids (TDS) at all wells sampled during the Phase III GDGI. The TDS data will aid in refining or confirming the areas that meet the federal classification as a potential source of drinking water of 10,000 milligrams per liter (mg/L) and the state potability criterion of 3,000 mg/L for TDS.

The Phase III GDGI is the third and final stage of the investigation and is intended to resolve the data gaps previously discussed. The third phase of the GDGI will include a third round of groundwater sampling at Parcel C; a limited third round of groundwater sampling at Parcel D; a second and third round of groundwater sampling at Parcel E; hydraulic testing at Parcels C and E; tidal studies at Parcels C, D, and E; and two rounds of groundwater sampling for analysis of radiological constituents at Parcels D and E (one Parcel B well and one Parcel C well will be included in the radiological background evaluation). The Phase III GDGI will also incorporate the data gathered during the first two phases of the investigation.

3.0 SITE LOCATION AND BACKGROUND

No change.

4.0 FIELD METHODS AND PROCEDURES

This section details the procedures and methods to be used in the field. Activities described in the following sections include inspection of monitoring wells (Section 4.1), measurement of water levels (Section 4.2), sampling of groundwater for chemical analysis (Section 4.3), installation of new monitoring wells (Section 4.4), development of newly installed wells (Section 4.5), calibration of field equipment (Section 4.6), decontamination (Section 4.7), management of investigation-derived waste (Section 4.8), hydraulic tests (Section 4.9), and tidal studies (Section 4.10).

4.1 INSPECTION OF MONITORING WELLS

Ongoing well inspections and repairs were performed throughout the Phase I and Phase II GDGI and will continue periodically throughout Phase III. A summary of current well maintenance and repair needs based on Phase II GDGI observations, as well as vault repairs and replacements, is shown in Table 4-1. Well inspection and maintenance will be an ongoing effort at HPS as construction activities are actively taking place and may pose increased risk for damage to monitoring wells. Damage to well casings, vaults, or concrete padding by heavy construction equipment and trucks are not uncommon as most monitoring wells at HPS were constructed as flush-mounted completion. Damage to the well protective casings, vaults, or concrete padding often cause wells to flood.

A basewide monitoring well inspection will be conducted at the beginning of the Phase III GDGI by a team of experienced field professionals. Well repair, redevelopment, or replacement will be performed as promptly as possible following identification of the problem. Phase III groundwater sampling will be conducted after the well repairs. In addition, temporary barricades will be erected, as necessary, to mitigate further damage or health and safety hazards.

All other minor repairs and maintenance will be performed immediately following the ongoing well inspection or prior to the sampling event that identifies the problem. A comprehensive table of well inspections and follow-on actions since the initial April 2000 survey will be presented in a separate document following completion of the Phase III GDGI.

4.2 MEASUREMENT OF WATER LEVELS

Water levels will be measured basewide at 229 A-aquifer, 40 B-aquifer, and 11 bedrock wells, as listed in Table 4-2 and shown on Figure 4-1. As noted in Table 4-2, 19 A-aquifer wells were added to the list of wells that are slated for measurement of water levels during the Phase III GDGI. Eight of these wells were recently installed in Parcel B to provide additional data for the map of the potentiometric surface of the A-aquifer. Eleven existing wells were added to increase coverage across HPS. All water levels will be measured within a 4-hour period of relatively low tidal fluctuation. The procedure described below will be followed so that groundwater levels will be measured when tidal fluctuation is minimal.

- One person will measure water levels in approximately 16 different wells over a period that will not exceed 4 hours. This procedure will allow an average of about 15 minutes for each well measurement, including time for travel between wells.
- Before the measurement period begins, all well covers will be unlocked and the covers unfastened to allow water levels to equilibrate to atmospheric pressure and facilitate speedy access to the well during the measurement period.
- The measurement period will fall during an interval of relatively low tidal fluctuation in San Francisco Bay.
- Measurement of groundwater levels will begin 1 hour before the high or low tide and will be completed in less than 4 hours (that is, no later than 3 hours after the high or low tide).
- During the measurement period, groundwater levels generally will be measured first in wells nearest the shore (that is, the locations expected to display the highest tidal efficiency). Water level measurement will proceed to wells farther from the shore (that is, the locations expected to display relatively lower tidal efficiencies), with the wells farthest from the shore measured last. Where tidal efficiencies have already been calculated, specific well data will be used to determine when the well will be monitored. This order of measurement of monitoring wells will minimize the effects of tidal fluctuation on the water levels because (1) wells that display the greatest degree of tidal fluctuation will be measured during a period

when the rate of change in water level as a result of tidal fluctuation is relatively low, and (2) wells that display lower tidal fluctuation will be measured during a period when the rate of change in water level caused by tidal fluctuation is relatively higher (but not as significant as for wells closer to the shoreline).

Water levels will be measured as set forth in TtEMI standard operating procedure (SOP) No. 14, "Revision No. 0, Static Water Level, Total Well Depth, and Immiscible Layer Measurement" (Appendix C), as amended in this section. Organic vapors will be measured initially with a photoionization detector or flame ionization detector, as discussed in Section 4.3.2 of this FSP. Accordingly, respiratory protection equipment will be immediately available to each team, but will not necessarily be worn while the team approaches each well. The field team will record all water level measurements on groundwater level measurement logs, and the field team leader will record activities in a bound field logbook (Appendix 1, QAPP Addendum).

4.3 GROUNDWATER SAMPLING

The following sections detail the proposed sampling locations, initial measurement of organic vapors and dissolved oxygen, sampling methods, and sample analysis. Additional details about chemical analysis of groundwater and QC samples are provided in the accompanying QAPP.

This FSP proposes two rounds of groundwater sampling for analysis of radionuclides. Sampling events will be spaced at least 3 months apart to avoid problems in auto-correlation that may result if samples are collected too close in space or time (EPA 1996). Auto-correlation results in an artificially low level of variance in the data, which biases the statistical evaluation.

4.3.1 Sampling Locations

Groundwater samples will be collected from monitoring wells identified in Table 4-3 and on Figures 4-2 through 4-5, in accordance with the schedule presented in Section 8.0. The specific rationale for the sampling locations in Parcels B, C, D, and E is presented in Tables 4-4 through 4-7. Monitoring wells within the tidally influenced zone (TIZ) (identified on Figures 4-1 through 4-5) will be sampled within a 4-hour period of relatively low tidal fluctuation to provide optimum comparison with the results of samples for other wells located outside the TIZ.

A total of 31 monitoring wells (Figure 4-5) were selected for sampling for analysis of radiological parameters in Parcels C, D, and E to evaluate potential site impacts (Tables 4-4 through 4-7). Five monitoring wells have been designated as background wells to be sampled to establish local background radioactivity. These five wells are upgradient of all known or suspected sources of site-related radioactivity. The five background wells are distributed across the facility to capture the chemical variability that results from spatial heterogeneities that may exist in shallow groundwater at HPS.

Most of the wells proposed for sampling under the radiological data gap study are located along the shoreline area in Parcel E (Figure 4-5). The 31 nonbackground wells were selected on the basis of historical source areas, areas where elevated levels of gross alpha or gross beta were previously identified, and additional areas to ensure basewide coverage.

Based on the Navy's initial review of the analytical results for monitored natural attenuation (MNA) under the Phase I and II GDGI, a reduced MNA sampling program can be implemented during the Phase III GDGI. Sampling during prior phases included a number of wells with limited data on volatile organic compounds (VOC) and petroleum hydrocarbons. Sampling for analysis of MNA parameters at these wells was eliminated for the Phase III GDGI because nondetect results from recent sampling confirmed the absence of VOCs and total petroleum hydrocarbons in groundwater. The sampling program was further limited to reduce redundancy and to focus on results from representative wells while maintaining coverage adequate to describe each area.

4.3.2 Initial Measurement of Organic Vapor and Dissolved Oxygen

No change.

4.3.3 Sampling Methods

Groundwater monitoring wells will be sampled in accordance with either TtEMI SOP No. 10, "Revision No. 3, Groundwater Sampling," or No. 15, "Revision No. 0, Groundwater Sample Collection Using Micropurge Technology" (Appendix C), as amended below. Micropurge sampling techniques, consistent with TtEMI SOP No. 15, will be the preferred procedure; however, standard well purging and sampling techniques in accordance with TtEMI SOP No. 10 may be used if well recharge rates are too low to conduct micropurge sampling. Based on field conditions seen during the Phase I and Phase II GDGI, the Navy anticipates that micropurge sampling will not be practical for a majority of the wells.

A Grundfos Rediflow-2 submersible (or equivalent nonoil-bearing) pump will be used to extract purge water efficiently from monitoring wells that contain large water columns (for example, 6-inch-diameter wells). Groundwater samples will be collected directly from the submersible pump at or below required flow rates and filtered as appropriate. Purge water will be managed as described in Section 4.8. The well will be considered ready for sampling after three well volumes have been purged from the well and after readings stabilize to within 10 percent of the previous measurement for each parameter (pH, temperature, and specific conductance) identified in the SOP, in addition to dissolved oxygen, oxidation-reduction potential, and turbidity. If the stabilization parameters do not fall within the specified ranges after three well volumes are removed, the well will be purged until the parameters stabilize or until four well volumes have been purged. If the well runs dry during purging before the specified amount of purge water has been withdrawn, the well will be allowed to recharge; after it has recharged to a minimum of 80 percent, one set of parameters will be measured, and the well will be sampled. Sample collection information will be recorded on monitoring well sampling forms, as shown in Appendix 1 of the accompanying QAPP.

In addition, sufficient amounts of groundwater must be collected to achieve low detection limits for analysis of radionuclides (Table 2-1, QAPP addendum). The precision of analysis for radionuclides is strongly related to the number of "counts" of the radioactivity: as counts increase, uncertainty decreases. The number of counts may be increased by lengthening the counting time, which increases analytical costs, or by increasing the size of the water sample to be analyzed.

4.3.4 Sample Analysis

As indicated in Table 4-3, groundwater samples from each well will be analyzed for a subset of the following site-specific analytes of concern: VOCs; semivolatile organic compounds (SVOC); pesticides and polychlorinated biphenyls (PCB); dissolved metals; hexavalent chromium; gross alpha and beta radioactivity; specific radionuclides; tritium; organophosphates; cyanide; ammonia nitrogen; total kjeldhal nitrogen; sulfide; total suspended solids (TSS); and MNA parameters. Radionuclides include americium-241; cesium-137; cobalt-60; europium-152 and -154; potassium-40; radium-226 and -228; strontium-90; and uranium-233, -235, and -238. MNA parameters include methane, ethane, ethene, ferrous iron, ferric iron, manganese (II), nitrate, nitrite, sulfate, dissolved oxygen, oxidation-reduction potential, chloride, total alkalinity, hydroxide alkalinity, carbonate alkalinity, bicarbonate alkalinity, calcium, magnesium, sodium, potassium, salinity, and TDS. Salinity and TDS at the A- and B-aquifer well pairs will also be measured to assess the need for water density corrections to calculations of vertical gradient. Table 2-1 in Appendix 2 of the accompanying QAPP addendum identifies the sample methods, containers, preservation, and holding times for all target constituents in groundwater samples. Section 6.1 of the FSP for the Phase I GDGI describes the sample identification (ID) system. (The sample ID system is unchanged.)

Sample bottles will be filled in accordance with the provisions of TtEMI SOP No. 10, Revision 3, "Groundwater Sampling," as amended below. Summarized below is the order for sample collection:

1. Collect samples for analysis for VOCs, methane, ethane, and ethene, in containers, as listed in Table 2-1 of the accompanying QAPP addendum. Samples for analysis of these parameters must be collected with zero headspace in the vial. After the sample to be analyzed has been sealed, invert the vial and inspect it for air bubbles. If air bubbles are present, discard the sample and resample the groundwater.

   If the groundwater reacts with the hydrochloric acid (HCl) preservative in the containers such that a preserved sample without bubbles cannot be collected, it is acceptable to collect the samples for analysis of VOCs, methane, ethane, and ethene, in unpreserved sample vials. Note on the field sheets and chain-of-custody records that the groundwater sample reacted with the HCl preservative and that an unpreserved sample was collected (because the holding time for the sample will be reduced). As an alternative, solid sodium bisulfate may be used as a preservative, contingent on the approval of the project chemist.

2. Collect the samples to be analyzed for other organic constituents (SVOCs, pesticides, PCBs, and organophosphates). Fill amber bottles to the neck.

3. Collect the samples to be analyzed for inorganic constituents (metals, hexavalent chromium, gross alpha and beta radioactivity, radium -226 and -228, remaining radionuclides, tritium, cyanide, fluoride, ammonia nitrogen, sulfide, total kjeldhal nitrogen, TSS, and remaining MNA parameters). Samples collected for analysis of dissolved metals will be filtered in the field, using disposable, high-capacity 0.45-micron filters. A Fisher Scientific filter (part number 12020) or equivalent will be used. Each sample to be analyzed for dissolved metals will be pumped through the filter using a peristaltic pump and Tygon tubing. New tubing and filters will be used for each sample to be analyzed for dissolved metals. Fill each preserved polyethylene sample bottle to the neck.

Immediately after samples have been collected, samples designated for analysis at an off-site laboratory will be transferred to a cooler maintained at 4 °C.

During the Phase II GDGI, a number of samples requiring acid preservation arrived at the laboratories above the maximum allowable pH level of 2; however, these conditions were promptly rectified and data quality was not compromised. In all cases, the sample bottles originally contained nitric acid preservative, as provided by the laboratories. The laboratories, as part of their standard procedures, tested the pH of each sample and added additional nitric acid, as necessary, to lower the pH to below 2. The laboratories confirmed that elevated pH does not affect analytical results if pH levels are brought down to the required levels prior to the analyses. At elevated pH levels, there is a potential for analyte adsorption to the walls of the sample container. However, this adsorption is reversible and desorption readily occurs when the pH is lowered to 2.

No changes regarding sample preservation are necessary for the Phase III GDGI. Specifically, sample pH will not be tested in the field nor will additional acid preservative be added in the field as there were no effects on previous analytical results and doing so might introduce additional risk of contaminating samples. The laboratories will follow their standard procedures to identify any samples with elevated pH.

4.4 WELL INSTALLATION

As part of the treatability studies of chemical oxidation in Parcel C at Installation Restoration (IR) sites 25 and 28, a total of 24 new wells were installed between December 2000 and February 2001: 12 A-aquifer wells, six B-aquifer wells, and six bedrock wells. In addition, three wells in the A-aquifer and three bedrock injection wells were installed at locations for the treatability study of chemical oxidation. Six new A-aquifer wells were installed in Parcel B during 2001. Five of these A-aquifer wells (IR07MW93A, IR07MW94A, IR07MW95A, IR18MW91A, and IR18MW92A) were installed in June 2001 for the water level study near the western boundary of Parcel B. The sixth well (IR10MW59A) was installed in March 2001 to collect samples for analysis of VOCs at IR-10. Installation of three wells (IR26MW46A, IR26MW47A, and IR26MW48A) is proposed in IR-26 to provide supplemental groundwater characterization (TtEMI 2001f).

New monitoring wells will be installed for Phase III in Parcels C and E for supplemental groundwater characterization, hydraulic testing, tidal studies (optional), and to replace decommissioned wells.

At Parcel C, three new monitoring wells for supplemental characterization of B-aquifer zones at IR-25 and south and east of IR-25 will be installed to help delineate the vertical and horizontal extent of VOCs in the area of remedial unit (RU) C5. Anticipated total depths of these wells are from 25 to 50 feet below ground surface (bgs).

Ten to 15 new wells will be installed in Parcels C and E for use in the hydraulic tests at both parcels. Designated pumping wells at Parcel C (four wells) and Parcel E (two wells) will be further evaluated to assess their well construction and yield conditions for their appropriateness to serve as pumping wells for hydraulic tests. If these wells do not meet the requirements for a pumping well, then up to six new wells, at depths to 30 feet bgs, will be installed to replace them. In addition, three new B-aquifer wells will be installed: one at RU-C1 (40 to 50 feet bgs), one at RU-C2 (40 to 50 feet bgs), and one at RU-C4/C7 (up to 25 feet bgs), all within 30 feet of the pumping well and for use as observation wells during the pumping tests. Three new wells in the bedrock water-bearing zone will be installed: one at RU-C1 (up to 40 feet bgs), one at RU-C2 (up to 60 feet bgs), and one at RU-C5 (up to 45 feet bgs), all within 30 feet of the designated pumping well for use as observation wells during the pumping tests. Well installations are also expected at Parcel E for pumping and observation wells to be used for the pumping tests.

Six near-shore wells (up to 20 feet bgs) for tidal studies may be installed at Parcel C as part of an optional field effort. Three locations at Parcel C have been identified for the optional tidal mixing studies. Because wells within 50 feet of the shoreline will be used for this study, two to three wells will be needed for each location in the tidal mixing study, depending on the distance from the shoreline of existing wells. Prior to committing to the tidal mixing study, the BCT will discuss the need to evaluate tidal mixing to identify point of compliance (POC) well locations. Ten new monitoring wells at Parcel C are expected to be installed to replace monitoring wells that are decommissioned during removal actions. The range of depths for these wells will be comparable to the decommissioned wells, which is approximately 10 to 70 feet bgs.

In general, the top of the screened interval for A-aquifer wells will extend at least 1 foot above the highest seasonal groundwater elevation. The screened interval (typically 10 feet long) for B-aquifer wells will be placed at the bottom of the B-aquifer (that is, directly overlying bedrock). All well drilling will be conducted by an experienced field geologist and supervised by a California Registered Geologist. Well drilling will be completed by a contractor licensed by the state of California. The contractor will use hollow stem auger (HSA), mud rotary, or air rotary casing hammer (ARCH) methods (see Appendix C for TtEMI SOP Nos. 20 and 21). HSA or ARCH drilling methods are preferred; however, mud rotary methods may be used as field conditions warrant. Based on field conditions encountered during the Phase I GDGI, HSA methods will be used in the A-aquifer, and ARCH methods will be used in the B-aquifer and bedrock zone.

During well drilling, undisturbed soil samples will be collected using a modified California sampler at minimum 5-foot intervals within the A-aquifer, Bay Mud sediments, B-aquifer sediments, and at closer intervals at the discretion of the field geologist. Continuous coring will be conducted in known VOC areas to provide a visual assessment of potential dense nonaqueous-phase liquid contamination. A field geologist will log the soil samples and will prepare a lithologic log using American Society for Testing and Materials (ASTM) Method D2488-93 (ASTM 1993a). All lithologic logging will be conducted under the supervision of a California Registered Geologist. In addition, a single soil sample from each new B-aquifer well at a depth within the screened interval will be analyzed for effective porosity by American Petroleum Institute (API) Method RP40 (API 1998). Samples from Bay Mud sediments will be analyzed for hydraulic conductivity by ASTM Method D5084 (ASTM 1993b).

The screen and well casing (fitted with a sediment trap and end cap) will be suspended in the center of the borehole with the aid of centralizers, generally spaced at 20 feet on the screen body and at 40 feet on the other sections of the casing. For shallow wells, at least two centralizers will be placed in each well: one at the bottom of the well and the other located 1 foot below the uppermost section of the sand filter pack. The centralizers will maintain an effective filter pack between the well screen and the formation materials, and facilitate an effective grout seal between the well casing and formation in deeper wells.

The silica sand pack for the monitoring wells will be poured through the drive casing to an elevation approximately 3 feet above the top of the well screen. The drive casing will be removed slowly from the borehole as the sand pack is poured around the screen to ensure that no gaps of bridging occur in the filter pack. During placement of the sand pack, the top of the sand pack will be measured frequently with a weighted tape to ensure that the bottom of the drive casing is not above the top of the sand pack. Before the bentonite seal is placed, the filter pack will be carefully remeasured to ensure correct installation of the sand pack. Additional material will be added to ensure that the position of the sand pack is correct. If a bentonite slurry is used, a 6-inch to 1-foot fine sand filter collar will be used at the top of the filter pack to prevent penetration of the filter pack by bentonite.

A 3- to 5-foot-thick bentonite seal will be placed above the top of the sand pack. Bentonite pellets, chips, slurry, or granular bentonite will be used, as determined by the geologist. After the bentonite seal has been placed, the remainder of the borehole annulus, up to 2 feet bgs, will be backfilled with cement-bentonite grout using a tremmie pipe. A minimum of 24 hours after the grout has been poured, a flush-mounted, traffic-rated concrete box with a bolted steel cover will be installed.

When wells are drilled using ARCH methods, the drive casing or augers will temporarily isolate the A- and B-aquifers and maintain the integrity of the Bay Mud aquitard. If mud rotary methods are used, the density of drilling fluid and the mud cake created on the sidewalls of the borehole will prevent intrusion of groundwater in the borehole annulus. The density of the drilling fluid and the presence of the mud cake prevents intrusion of water from the aquifer into the borehole while drilling the pilot boring and during geophysical logging and maintains the integrity of the Bay Mud aquitard.

4.5 WELL DEVELOPMENT

No change.

4.6 CALIBRATION OF FIELD EQUIPMENT

No change.

4.7 DECONTAMINATION

No change.

4.8 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

No change.

4.9 HYDRAULIC TESTS

Four constant-rate pumping tests will be performed at Parcel C, and two constant-rate pumping tests will be performed at Parcel E. The objectives of the hydraulic tests are as follows:

- Evaluate hydraulic characteristics of the shallow aquifer system (primarily A-aquifer zone) at Parcels C and E.
- Calculate aquifer hydraulic parameters such as transmissivity, hydraulic conductivity, storativity, and specific yield for the A-aquifer zone at Parcels C and E.
- Evaluate hydraulic communications between the A-aquifer, B-aquifer, and bedrock water-bearing zone at Parcels C and E.
- Provide detailed hydrogeologic information for treatability studies in Parcels C.
- Refine the hydrogeologic conceptual models for Parcels C and E and local RUs.

Hydraulic testing will be conducted at four RUs (C1, C2, C4/C7, and C5) at Parcel C. One pumping well will be selected in each area. The hydraulic tests will be conducted sequentially at the four RUs to avoid the potential for interference. Pumping tests will be conducted at two potential locations in Parcel E: one near the IR-01/21 sheet pile wall and groundwater extraction system and one at IR-03.

The following criteria were considered when selecting pumping and observation wells:

- One A-aquifer well will be selected as the pumping well in each RU. At RU-C4/C7, where bedrock is shallow, a well screened in the upper bedrock zone will be selected as the pumping well.
- The pumping well will have a minimum diameter of 4 inches and a minimum screen interval of 10 feet.
- One or more observation wells will be used in each of the water-bearing zones that are being evaluated.
- Observation wells will be screened in multiple hydrostratigraphic units and will be located radially outward from the pumping well to ensure spatial coverage.
- Observation wells screened in the A-aquifer will be selected within 30 feet of the pumping well. Observation wells screened in the B-aquifer or bedrock water-bearing zone will be selected within 10 feet of the pumping well.

The pumping and observation wells that are being considered for hydraulic testing are listed in Table 4-8 and are shown on Figure 4-6. The final selection of wells for the pumping tests will be based on field inspections.

The proposed pumping wells will be further evaluated for condition and screen level. It is desirable to select a pumping well that is fully penetrating, or a new pumping well may be required. The information on communication between A-aquifer zone and B-aquifer zones is important in refining the site conceptual model and in understanding the fate and transport of contaminants in the plume; therefore, the proposed pumping tests should include sufficient coverage for the B-aquifer zones. Only one B-aquifer well for each RU can be used for the pumping test at RU-C1 and RU-C2. Therefore, an additional B-aquifer well should be installed at each of two RUs. The location of the new B-aquifer wells should be within 10 feet of the pumping well; well installation details for these wells are discussed in Section 4.4.

Static water level measurements (background water levels) will be collected for at least 24 hours before the hydraulic tests. The background water level data will be used to discern natural groundwater trends from drawdown induced by pumping. These natural groundwater trends may result from seasonal water fluctuations, rainfall infiltration, and tidal influences. A step-drawdown test and a constant-rate pumping test will be conducted at each test location. Testing at each well will require approximately 1 week of field time, including setting up equipment and conducting the step-drawdown test and constant-rate pumping test.

4.9.1 Step-Drawdown Test

The step-drawdown test is used to evaluate the performance of wells in terms of the specific capacity at various pumping rates. This information will be used to select the optimum pumping rate for the time period estimated for the constant-rate test. Prior to beginning the step-drawdown test, the well's maximum pumping rate will be estimated using data from well purging. This rate will be divided into three or four steps of sequentially increasing discharge rate. The step-drawdown test will be completed during a 1-day period, and full recovery will be completed overnight. Drawdown will be collected by a preprogrammed data logger and downhole pressure transducers using a logarithmic time scale. The data will be reviewed in the field by the field hydrogeologist. When drawdown has stabilized and the data can be projected in time to the assumed completion of the constant-rate test (approximately 72 hours), the discharge rate will be increased to the next step, the data logger will be stepped, and the data-logging process will be repeated. Since the early steps will occupy more space on the semi-log graphs, these time steps will be kept as short as possible (generally 20 to 30 minutes for step 1, and approximately 60 minutes for step 2). Discharged water will be stored in a portable storage tank prior to characterization and disposal. When the step-drawdown test is complete, 100-percent water level recovery will be achieved before the field crew proceeds with the constant-rate pumping test. For lower yield portions of the aquifer where recovery may not occur for a long time, at least 95 percent water level recovery will be achieved.

4.9.2 Constant-Rate Pumping Test

An optimal pumping rate will be selected based on a review of the step-drawdown test results. It is important to stress the aquifer with as high a pumping rate as possible, but not so high that the well is pumped dry during the test period. The constant-rate pumping tests will be conducted for approximately 72 hours, which is the duration generally adequate for testing an unconfined aquifer (Driscoll 1995). It is important to ensure that the aquifer is fully recovered from the step-drawdown test before the constant-rate pumping test begins so that early drawdown can be accurately recorded. Without the data on early drawdown, it may be impossible to obtain accurate transmissivity and storage parameters for the aquifer. During the test, groundwater will be pumped at a constant rate from the pumping well into a portable storage tank. Pressure transducers connected to data loggers will be used to record time and drawdown data from the pumping wells and nearby observation wells. Recovery data will also be collected after the pump has been turned off. Data loggers will be preprogrammed to best collect the drawdown and recovery data.

A constant pumping rate is critical to the success of the pumping test; as such, every effort will be made to ensure that the pump and power unit have the capacity to operate at a constant pumping rate for 72 hours. The pumping rate will not be allowed to vary by more than 15 percent. An inline flow meter will record the pumping rate every 2 minutes during the first 2 hours of the test and every 30 minutes thereafter. A 5-gallon bucket and stopwatch will be used to verify the accuracy of the inline flow meter, and multiple control valves will help check flow rates.

Data from the pumping test will be analyzed using Aqtesolv for Windows, a widely applied aquifer test interpretation software package. Analytical methods will be selected based on site-specific hydrogeologic conditions, drawdown responses of the observation wells, and boundary effects that are identified during the pumping tests. It is expected that the A-aquifer is under an unconfined condition; therefore, the Neuman delayed yield solution for unconfined aquifer will primarily be used in the analysis of the pumping test data. Hantush-Jacob, Hantush, and Moench solutions for leaky aquifer and fractured bedrock rock conditions will also be used to conduct alternative data interpretations (Neuman 1975; Hantush and Jacob 1955; Hantush 1960; Moench 1984, 1993). Aquifer hydraulic parameters, including transmissivity, hydraulic conductivity, storativity, specific yield, and leakance factor, will be estimated from drawdown and recovery data interpretation. In all of these analyses, the effects of partially penetrating pumping and observation wells, which were not screened across the entire thickness of the aquifer, will be evaluated if relevant.

4.10 TIDAL STUDIES

Tidal studies will be conducted at multiple locations across HPS. The objectives of the tidal studies are as follows:

- Estimate the linear inland extent of tidal (pressure) influence.
- Evaluate the mean groundwater flow patterns close to the shore.
- Quantify tidal influence parameters at different locations of HPS.
- Characterize the tidal (surface water) mixing zone (optional field effort).
- Evaluate whether storm drain lines are acting as preferential pathways for contaminant movement to the Bay

The tidal study areas include IR-28 and IR-29 (Parcel C), IR-22 (Parcel D), and the shoreline in Parcel E (Figure 4-7). Table 4-9 lists the wells to be included in each tidal study. The historical delineations of the TIZ at Parcels C, D, and E are presented on Figures 4-2, 4-3, and 4-4, respectively. Tidal study locations are in areas with confirmed or potential groundwater contamination near the shoreline.

The tidal mixing study is an optional field effort. Discussions will be held with the BCT to determine whether the tidal mixing zone study is needed to help select potential POC well locations. If conducted, the tidal studies under the Phase III GDGI will include three components of data collection: (1) continuous measurement of groundwater elevation (every 15 minutes) at selected monitoring wells near the shore through multiple tidal cycles over a 10-day period; (2) continuous readings of barometric pressure; and (3) continuous readings (at maximum 1-hour time interval) of specific conductance at selected shoreline wells through the same tidal cycles. The measurements of specific conductance will concentrate on the area within 50 feet of the shoreline to estimate mixing between sea water and fresh water (Section 4.10.2).

Data on water elevation will be collected by pressure transducers that will be installed in a network of monitoring wells or piezometers to measure and record changes in water level and temperature at 15-minute intervals over a period of 10 days. Calculation of a mean groundwater elevation generally requires a minimum of 3 days of water level data. Collection of data over the 10-day period will provide more than the minimum needed to calculate mean groundwater elevation. In addition, a longer study period (10 days versus 3 days) provides better coverage of biweekly variations in the tidal cycle; therefore, derived tidal correction parameters (tidal efficiency and time lag) are more representative. The tidal study will be conducted during the maximum tide of the year, which generally occurs during April. A specific date will be selected based on further evaluation of the tidal prediction chart.

Data on specific conductance will be collected at a limited set of monitoring wells or piezometers from each network. The wells or piezometers will be located close to the shoreline, preferably within a 50-foot range. The goal of measuring specific conductance during the tidal cycles is to evaluate variations in water salinity with changes in the tide. If specific conductance shows variation similar to the tide, groundwater mixes with the sea water as a result of the tide; otherwise, groundwater and sea water do not mix during individual tidal cycles. It is believed that the zone of tidal mixing is small, so data on conductivity will be collected only at shoreline wells.

Evaluation and interpretation of data from the tidal study will include:

- Computation of mean water level using the Serfes method (Serfes 1991).
- Assessment of time lags for all tidally influenced wells.
- Estimation of tidal efficiency to characterize the influence of tidal pressure (energy) on groundwater level.
- Measurement of barometric efficiency, which describes how the water level responds to changes in atmosphere pressure. Barometric fluctuations are not commonly observed in wells that tap an unconfined aquifer because changes in atmospheric pressure are transmitted equally to the column of water in the well and to the water table through the unsaturated zone. However, this information will assist with evaluation of aquifer compressibility.

4.10.1 Water Level, Specific Conductance, and Temperature Measurements

The Troll 9000 (In-Situ, Inc.), or equivalent multiparameter monitoring probes and pressure transducers that are capable of measuring water levels, conductivity, and temperature, will be used to collect the data. The probes have internal data-logging capabilities and will record data at 15-minute intervals. Data will be downloaded from the probes to a laptop computer for analysis.

4.10.2 On-Site Tide Measurements

One station will be established on site near Building 235 to measure variations in the water level of the Bay. Data on specific conductance and temperature for sea water in the Bay will also be collected throughout the tidal studies. The data at the HPS shoreline will be compared with tidal data published by the National Oceanic and Atmospheric Administration (NOAA) to validate that the NOAA data collected at the Golden Gate Bridge station are consistent with on-site measurements (after correction). A 4-inch-diameter slotted polyvinyl chloride (PVC) pipe will be fixed to the seawall and extended a sufficient distance below the mean lower low water level (about 3 feet below mean sea level) to collect data over the full range of tidal fluctuations. The PVC pipe will protect the probe from damage and mitigate the effects of wave action. Water level, specific conductance, and temperature will be recorded at 15-minute intervals, and the data will be downloaded from the data logger or probe to a laptop computer during and at the end of the tidal studies.

5.0 FIELD QUALITY ASSURANCE AND QUALITY CONTROL SAMPLES

No change.

6.0 SAMPLE HANDLING, SHIPMENT, AND CHAIN OF CUSTODY

No change.

7.0 HEALTH AND SAFETY

A basewide HSP was prepared for field work at HPS (TtEMI 2000b). The basewide HSP provides information about the physical, biological, and chemical hazards associated with the various field activities to be conducted during the investigation. The Navy's review of the basewide HSP indicated that possible new hazards related to potential radiological contamination have been adequately addressed.

8.0 SCHEDULE

Table 8-1 provides the schedule for the HPS Phase III GDGI. The schedule relies on a number of assumptions that, when fully defined, may result in changes or updates to the proposed schedule. Critical assumptions are related to document review times. Table 8-1 also provides the schedule for submittal of the Phase III GDGI information packages for Parcels C and E. The BCT's evaluation of the Phase III information packages will be incorporated into the revised FSs for Parcels C and E.

9.0 REPORTING

Data on water levels and water quality gathered during the Phase III GDGI will be presented to the BCT in information packages for each parcel, similar to the information packages for the Phase II GDGI. Data on water levels and water quality gathered during the data gap study of radionuclides in shallow groundwater at HPS will be presented in a report that evaluates and discusses the analytical results and the outcome of statistical testing. EPA's data quality assessment process (EPA 2000b) and Navy guidance (Navy 1999) will be followed during the evaluation of data for this data gaps study.

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FIGURES

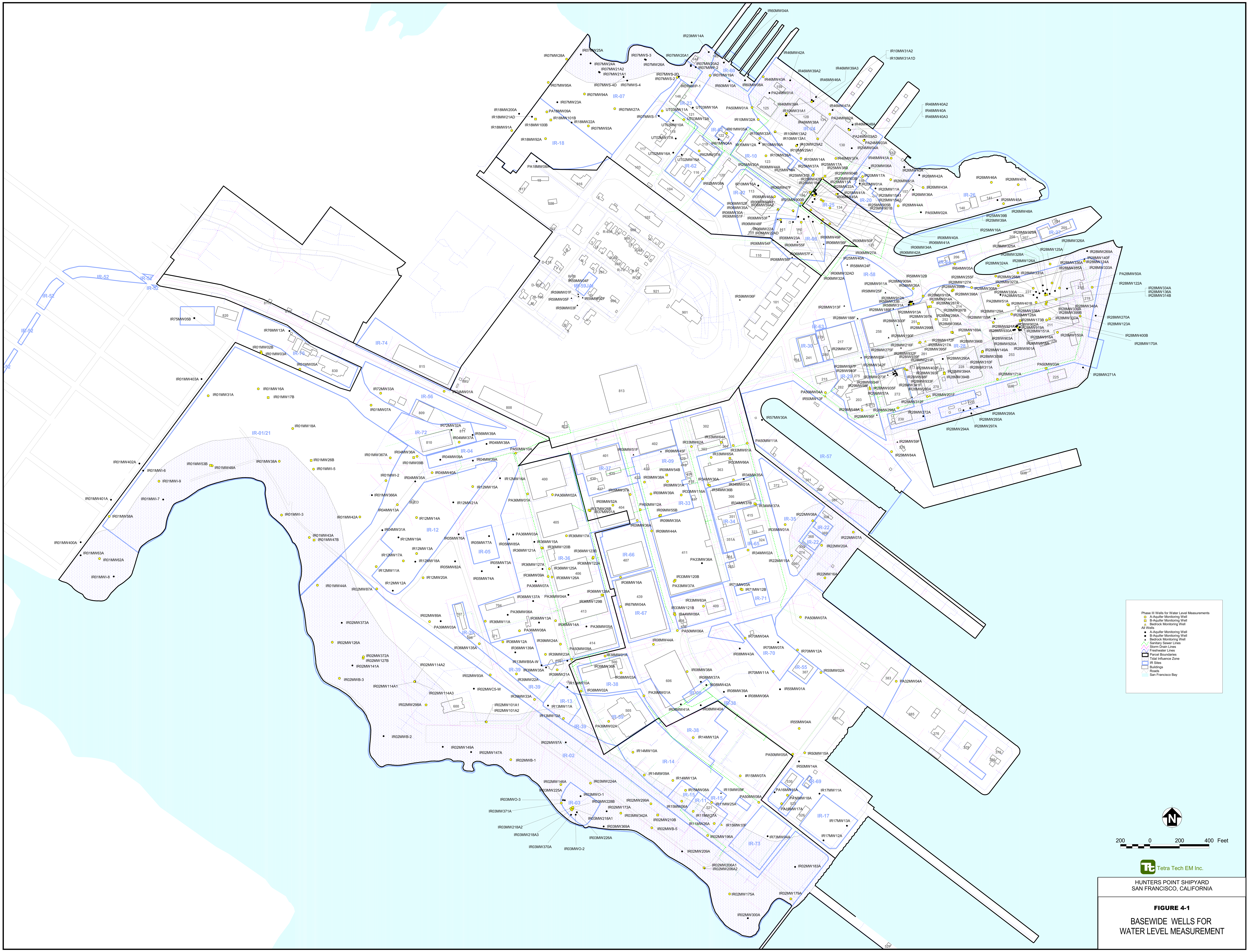
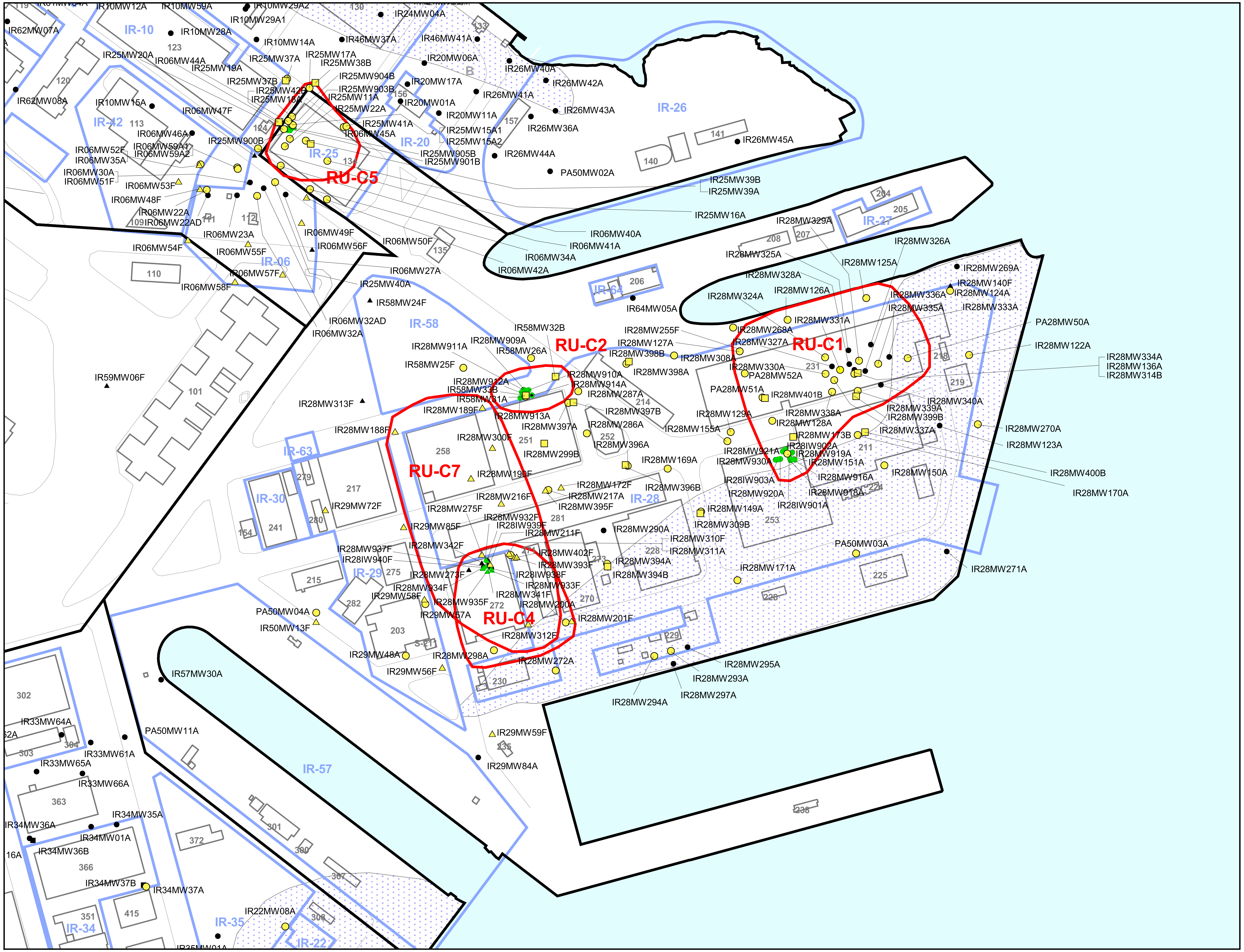
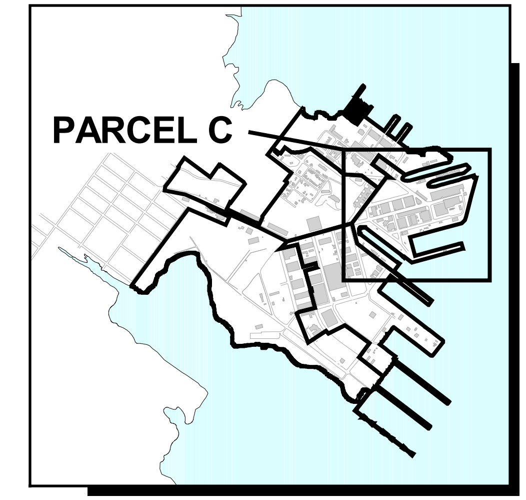


FIGURE 4-1

BASEWIDE WELLS FOR WATER LEVEL MEASUREMENT





Phase III Wells to be Sampled
- A-Aquifer Monitoring Well
- B-Aquifer Monitoring Well
- Bedrock Monitoring Well

New Wells
- A-Aquifer Monitoring Well
- B-Aquifer Monitoring Well
- Bedrock Monitoring Well

All Wells
- A-Aquifer Monitoring Well
- B-Aquifer Monitoring Well
- Bedrock Monitoring Well

Revised Remedial Units
Remedial units shown represent areas with point exceedances that are proposed for further evaluation.
Parcel Boundaries
IR Sites
Tidal Influence Zone
Buildings
Roads
San Francisco Bay

N

100 0 100 200 Feet

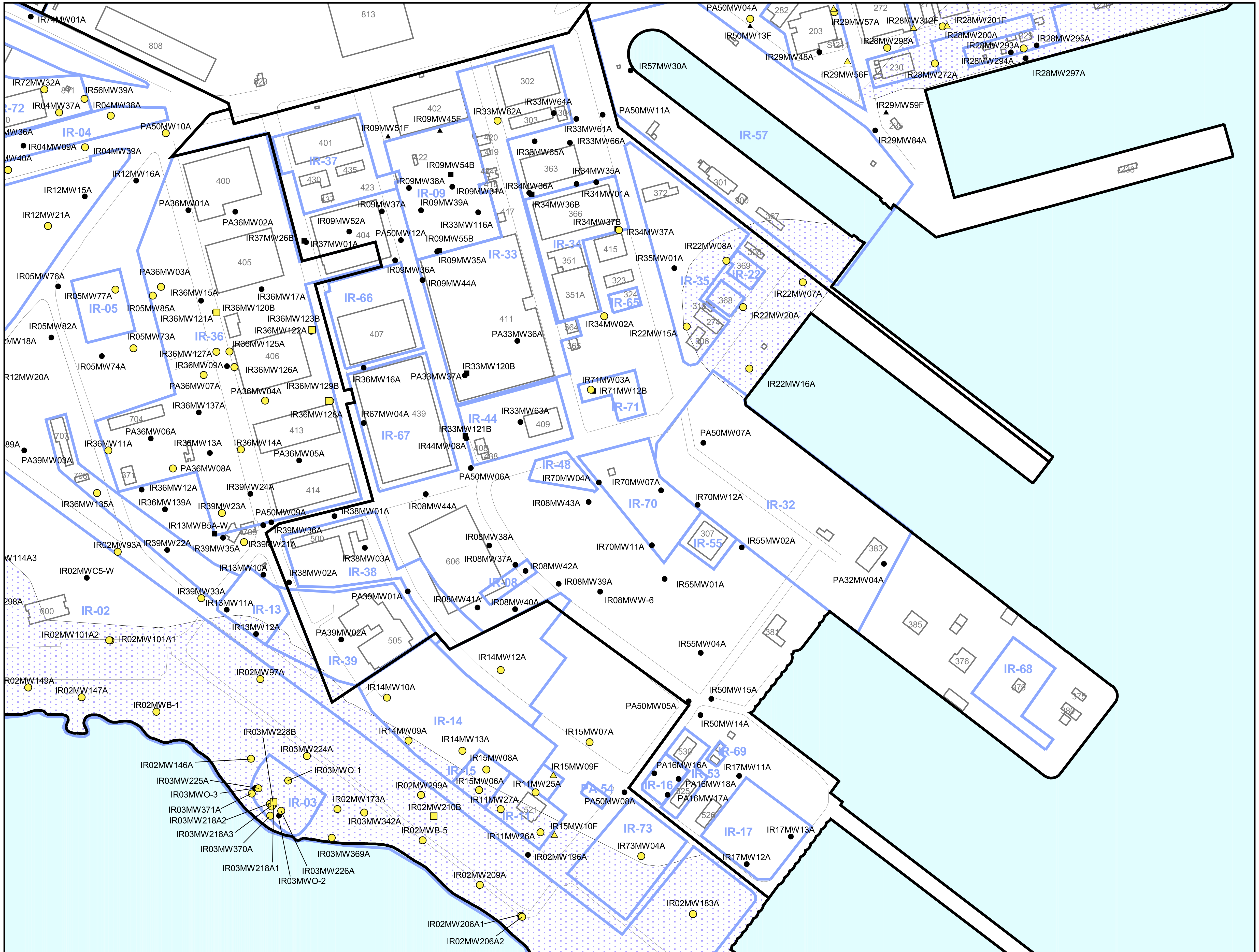
Tetra Tech EM Inc.

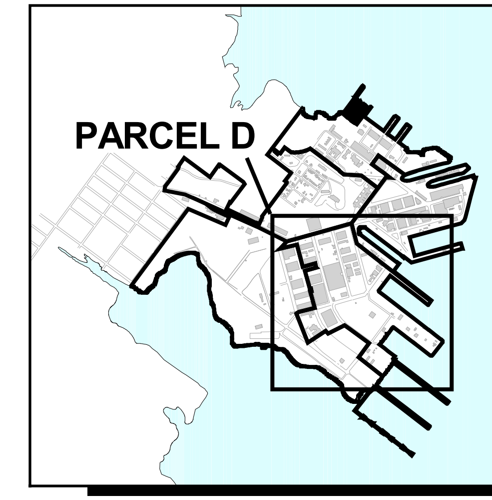
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE 4-2

PARCEL C
WELLS FOR RESAMPLING TO CONFIRM
EXTENT OF REMEDIAL UNITS

02/01/02 v:\hunters point\projects\gw data gaps\phase iii gdgi\phase iii backup.apr TtEMI-SF Debbie Cheng





Phase III Wells to be Sampled
- A-Aquifer Monitoring Well
- B-Aquifer Monitoring Well
- Bedrock Monitoring Well

All Wells
- A-Aquifer Monitoring Well
- B-Aquifer Monitoring Well
- Bedrock Monitoring Well
- Parcel Boundaries
- IR Sites
- Tidal Influence Zone
- Buildings
- Roads
- San Francisco Bay

N

200 0 200 400 Feet

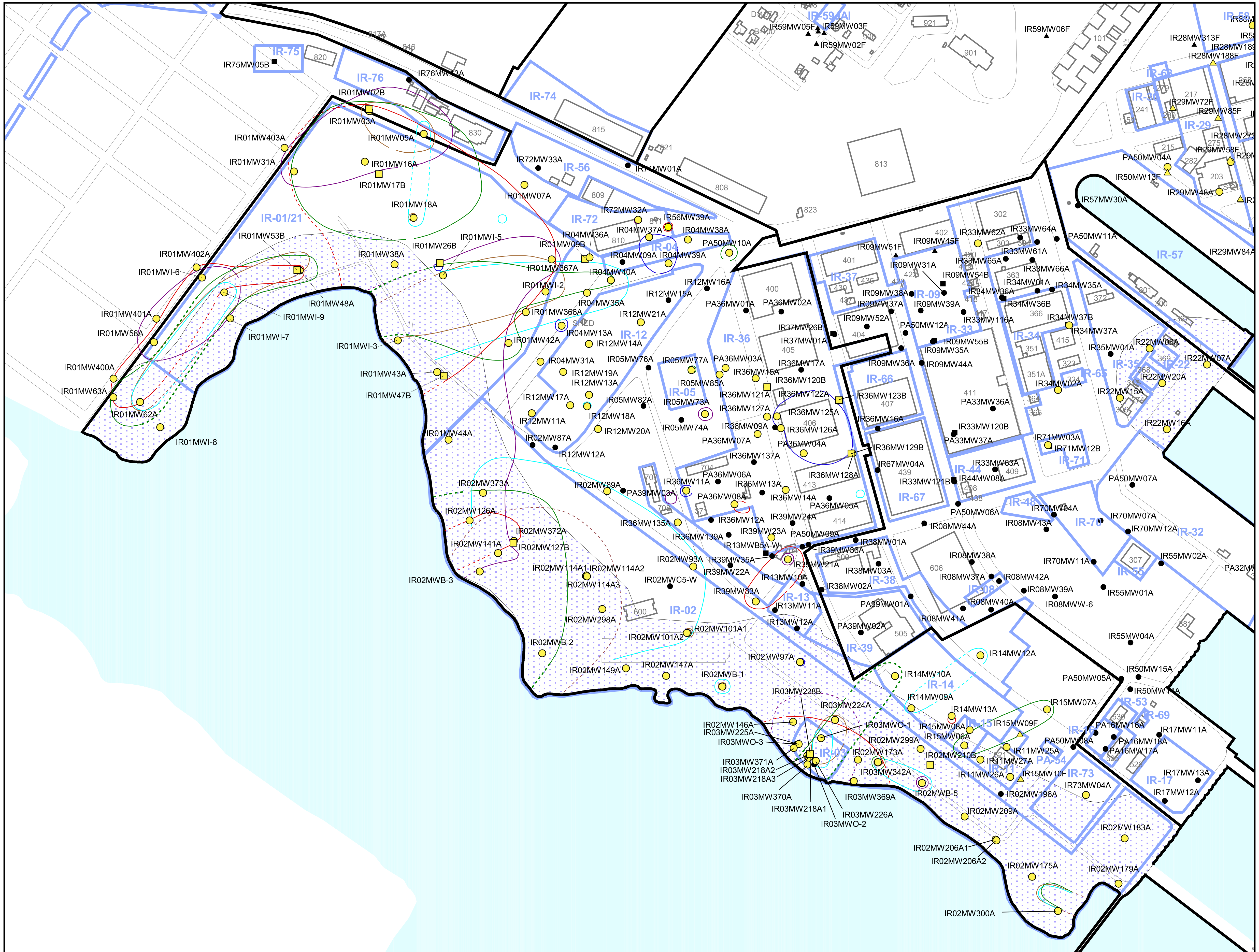
Tetra Tech EM Inc.

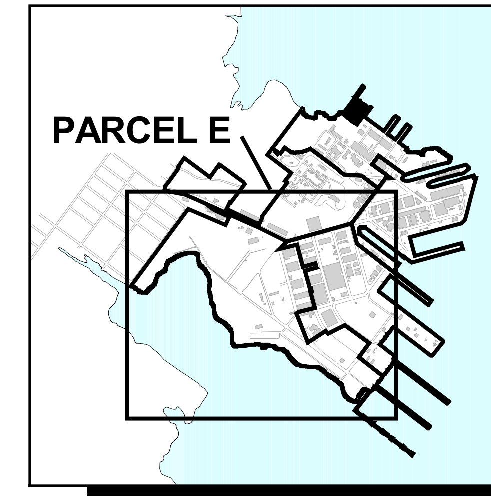
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE 4-3

PARCEL D
WELLS FOR RESAMPLING TO CONFIRM
EXTENT OF REMEDIAL UNITS

02/01/02 v:\hunters point\projects\gw data gaps\phase iii gdgi\phase iii backup.apr TtEMI-SF Debbie Cheng





Phase III Wells to be Sampled
- A-Aquifer Monitoring Well
- B-Aquifer Monitoring Well
- Bedrock Monitoring Well

All Wells
- A-Aquifer Monitoring Well
- B-Aquifer Monitoring Well
- Bedrock Monitoring Well
- Isoconcentration Contour Line for Benzene (1 μg/L)
- Isoconcentration Contour Line for Trichloroethene (5μg/L)
- Isoconcentration Contour Line for Lead (10 μg/L)
- Isoconcentration Contour Line for Nickel (100 μg/L)
- Isoconcentration Contour Line for Chromium (50μg/L)
- Isoconcentration Contour Line for Aroclor-1260 (0.03μg/L)
- Parcel Boundaries
- IR Sites
- Buildings
- Roads
- Tidal Influence Zone
- San Francisco Bay

Note: Dashed lines represent inferred isoconcentration contours.

N

200 0 200 400 Feet

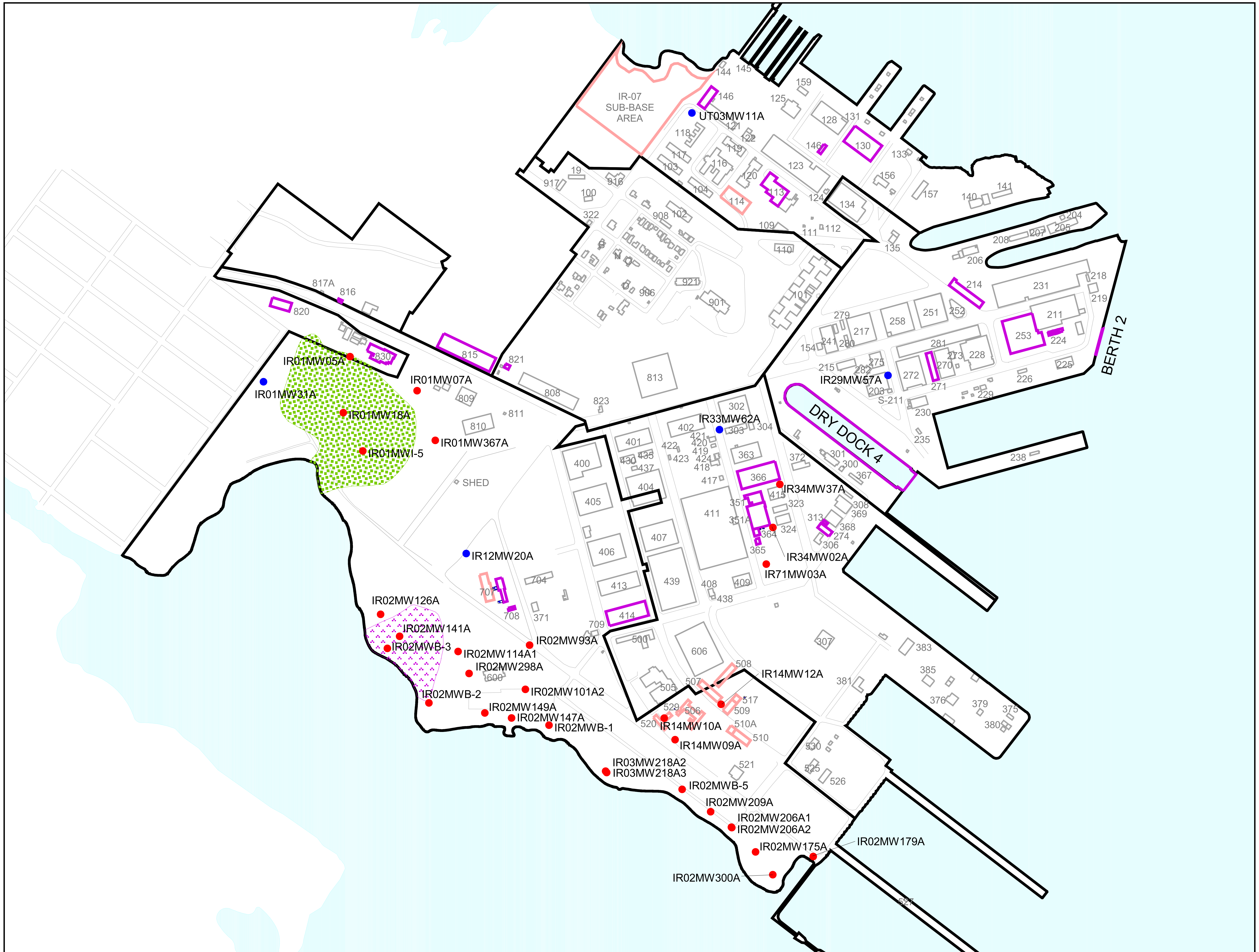
Tetra Tech EM Inc.

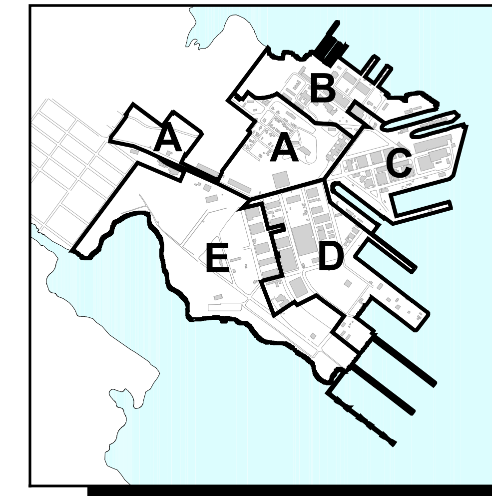
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE 4-4

PARCEL E
WELLS FOR RESAMPLING TO CONFIRM
EXTENT OF CONTAMINATION

02/01/02 v:\hunters point\projects\gw data gaps\phase iii gdgi\phase iii backup.apr TtEMI-SF Debbie Cheng





Wells to be Sampled (Total of 36 Wells)
- A-Aquifer Monitoring Wells
- Background Monitoring Wells
- Radiation Removal Areas
- Buildings/Areas Associated with Radiological Operations
- Demolished Buildings Associated with Radiological Operations
- IR-01/21 Landfill Area
- IR-02 Disposal Area
- Parcel Boundaries
- Buildings
- Roads
- San Francisco Bay

N

400 0 400 800 Feet

Tetra Tech EM Inc.

HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE 4-5

WELLS PROPOSED FOR SAMPLING
RADIONUCLIDES

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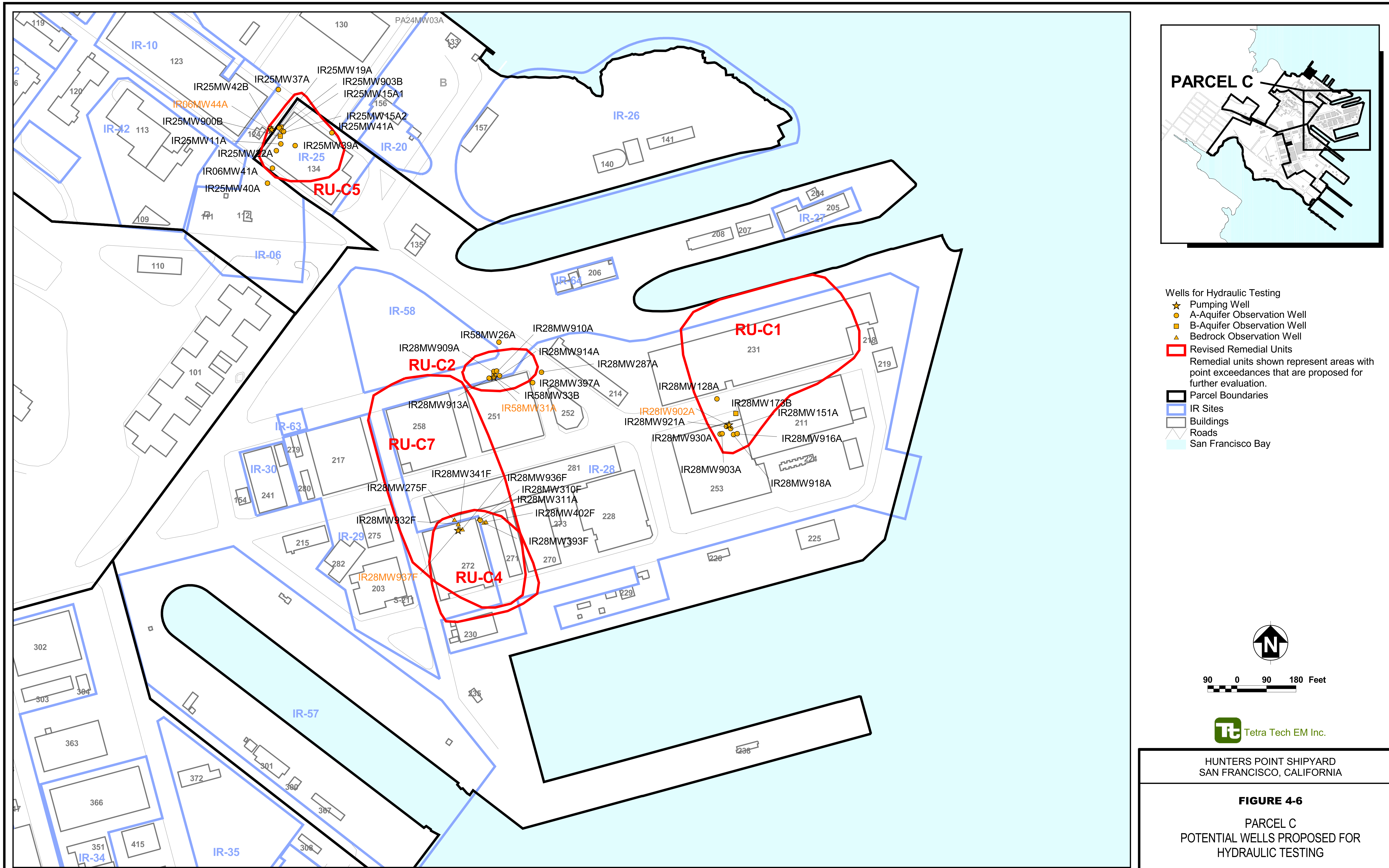


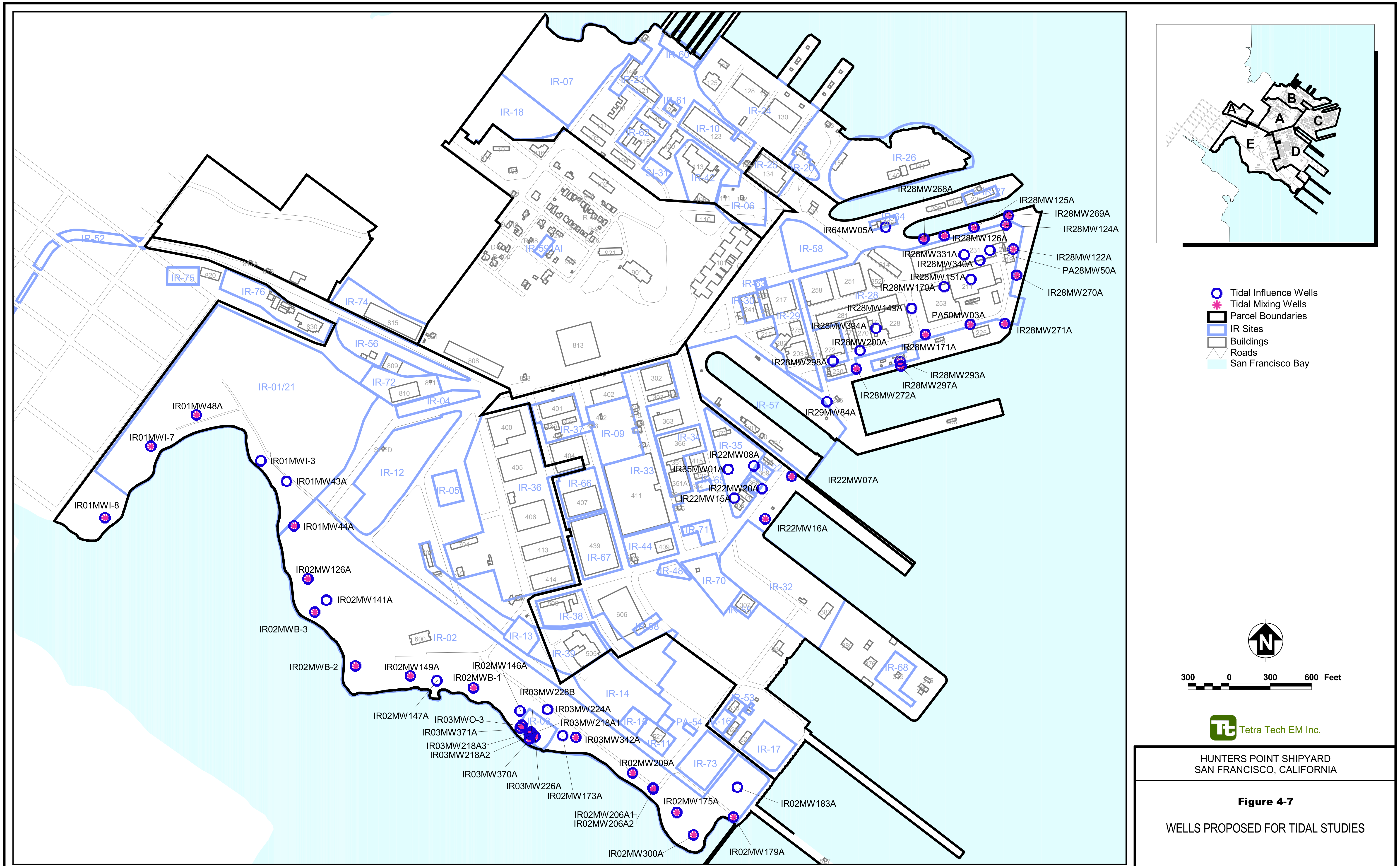
Tetra Tech EM Inc.

HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE 4-6

PARCEL C
POTENTIAL WELLS PROPOSED FOR
HYDRAULIC TESTING

02/01/02 v:\hunters point\projects\gw data gaps\phase iii gdgi\phase iii pump and tidal.apr TtEMI-SF Debbie Cheng



HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

Figure 4-7

WELLS PROPOSED FOR TIDAL STUDIES

12/18/01 v:\hunters point\projects\gw data gaps\phase iii gdgi\phase iii pump and tidal.apr TtEMI-SF Debbie Cheng

TABLES

TABLE 1-1

SIGNIFICANT CHANGES TO FIELD SAMPLING PLAN ADDENDUM FOR PHASE III GROUNDWATER DATA GAPS INVESTIGATION HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Change to FSP	FSP Section Number
Characterization of the B-aquifer is complete in Parcel D.	2.0
In Parcel D, the A-aquifer will be characterized only in IR-22.	2.0
Hydraulic tests will be conducted in four locations in Parcel C and at two locations in Parcel E.	2.0, 4.9
Tidal influence and tidal mixing zone will be studied in Parcels C, D, and E. The tidal mixing study is an optional field effort. Discussions will be held with the BCT to determine whether the mixing zone study is needed to help select potential point of compliance well locations.	2.0, 4.10
A data gap study for radionuclides in the A-aquifer will be conducted in Parcels D and E.	2.0, 4.3
Sampling for analysis of MNA parameters is eliminated from approximately 75 wells in Parcels C and E.	2.0, 4.3
New monitoring wells will be installed in Parcels C and E for supplemental groundwater characterization, hydraulic testing, potential tidal studies, and to replace decommissioned wells.	4.4
Twelve wells were added for sampling in IR-06.	4.3
SWRCB analytes for solid waste landfills were added to 20 wells in IR-01/21, Parcel E.	4.3

Notes:

BCT	Base Realignment and Closure Cleanup Team
FSP	Field sampling plan
IR	Installation Restoration
MNA	Monitored natural attenuation
SWRCB	State Water Resources Control Board

TABLE 4-1

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
A	IR06	IR06MW54F	Bedrock	452760.77	1460933.96	52.5	35.86	35.02	42.0	52.0	-6.14	-16.14	PVC	4	12/9/93	ACH	10		Inspected August 2001; NPI
A	IR06	IR06MW58F	Bedrock	452645.33	1461063.91	38.5	26.56	25.91	28.0	38.0	-1.44	-11.44	PVC	4	6/1/94	ACH	10		Inspected April 2000; NPI
A	IR06	IR06P54FA	A	452734.61	1460931.82	52.0	36.02	35.48	42.0	52.0	-5.98	-15.98	PVC	4	6/26/95	ACH	10		Inspected August 2001; NPI
A	IR18	PA18MW08A	A	453293.88	1459336.46	25.0	25.12	24.67	10.0	25.0	15.12	0.12	PVC	4	1/31/91	HSA	11		Inspected April 2000; NPI
A	IR59	IR59MW01F	Bedrock	452380.76	1459619.89	82.5	121.97	121.36	63.0	82.5	58.97	39.47	PVC	4	12/15/93	ACH	10	4/96	Decommissioned
A	IR59	IR59MW02F	Bedrock	452321.17	1459611.66	66.0	125.08	124.34	46.0	66.0	79.08	59.08	PVC	4	3/8/94	ACH	10	4/96	Decommissioned
A	IR59	IR59MW03F	Bedrock	452372.74	1459647.72	107.5	124.74	124.14	87.0	107.0	37.74	17.74	PVC	4	3/8/94	ACH	10	4/96	Decommissioned
A	IR59	IR59MW04F	Bedrock	452395.49	1459617.25	84.5	120.96	120.37	64.0	84.0	56.96	36.96	PVC	4	3/4/94	ACH	10	4/96	Decommissioned
A	IR59	IR59MW05F	Bedrock	452369.42	1459571.83	69.0	122.66	120.75	49.0	69.0	73.66	53.66	PVC	4	3/11/94	ACH	10	4/96	Decommissioned
A	IR59	IR59MW06F	Bedrock	452358.38	1460709.99	17.5	30.07	31.88	12.0	17.0	18.07	13.07	PVC	4	1/10/95	ARCH	10	4/96	Decommissioned
B	IR06	IR06MW22A	A	452898.49	1460985.84	10.0	10.38	10.00	5.0	10.0	5.38	0.38	PVC	2	6/27/00	HSA	8		Well condition assessment pending
B	IR06	IR06MW22AD	A	452883.58	1460989.21	9.0	10.68	10.08	4.0	9.0	6.68	1.68	PVC	4	5/31/90	HSA	12	4/30/97	Decommissioned
B	IR06	IR06MW23A	A	452883.62	1461069.53	13.0	10.44	9.77	5.0	13.0	5.44	-2.56	PVC	4	5/31/90	HSA	12	b	Decommissioned
B	IR06	IR06MW27A	A	452885.81	1461203.77	9.2	10.18	11.75	2.5	9.2	7.68	0.98	PVC	4	6/1/90	HSA	12	b	Decommissioned
B	IR06	IR06MW30A	A	452919.32	1461105.51	17.0	10.43	9.87	7.0	17.0	3.43	-6.57	PVC	4	5/30/90	HSA	12	4/30/97	Decommissioned
B	IR06	IR06MW32A	A	452881.90	1461125.09	15.0	10.32	9.90	5.0	15.0	5.32	-4.68	PVC	2	6/27/00	HSA	8		Well condition assessment pending
B	IR06	IR06MW32AD	A	452903.41	1461143.12	14.0	10.60	10.02	6.5	14.0	4.10	-3.40	PVC	4	6/1/90	HSA	12	4/30/97	Decommissioned
B	IR06	IR06MW35A	A	452968.71	1460968.71	15.0	10.28	9.73	6.0	15.0	4.28	-4.73	PVC	4	6/4/90	HSA	12		Inspected April 2000; NPI
B	IR06	IR06MW46A	A	453055.28	1460945.44	17.0	10.03	9.46	7.0	17.0	3.03	-6.98	PVC	4	9/17/92	HSA	11		Inspected April 2000; NPI
B	IR06	IR06MW47F	Bedrock	452994.51	1461118.14	40.0	10.16	9.66	30.0	40.0	-19.84	-29.84	PVC	4	10/23/91	NX CORING	9.9		Inspected April 2000; NPI
B	IR06	IR06MW48F	Bedrock	452901.75	1460967.24	20.0	10.60	10.03	10.0	20.0	0.60	-9.40	PVC	4	10/22/91	NX CORING	9.9	10/28/98	Decommissioned
B	IR06	IR06MW49F	Bedrock	452808.23	1461248.19	19.0	11.94	11.29	9.0	19.0	2.94	-7.06	PVC	4	10/22/91	NX CORING	9.9	8/15/97	Decommissioned
B	IR06	IR06MW50F	Bedrock	452878.48	1461261.81	30.5	11.11	10.38	20.0	30.0	-8.89	-18.89	PVC	4	12/8/93	ACH	10		Inspected April 2000; NPI
B	IR06	IR06MW51F	Bedrock	452920.54	1461102.41	37.5	10.76	10.19	27.0	37.0	-16.24	-26.24	PVC	4	12/7/93	ACH	10	6/4/97	Decommissioned
B	IR06	IR06MW52F	Bedrock	452968.59	1460965.60	29.5	10.28	9.70	19.0	29.0	-8.72	-18.72	PVC	4	12/7/93	ACH	10		Inspected April 2000; NPI
B	IR06	IR06MW53F	Bedrock	452922.46	1460908.13	24.5	10.88	10.51	14.0	24.0	-3.12	-13.12	PVC	4	3/8/94	ACH	10		Inspected April 2000; NPI
B	IR06	IR06MW55F	Bedrock	452749.85	1461100.11	46.5	32.94	32.34	36.0	46.0	-3.06	-13.06	PVC	4	12/9/93	ACH	10		Vault replaced 8/02/01.
B	IR06	IR06MW56F	Bedrock	452734.33	1461276.93	44.0	26.03	25.04	33.5	43.5	-7.47	-17.47	PVC	4	12/10/93	ACH	10		Inspected April 2000; NPI
B	IR06	IR06MW57F	Bedrock	452665.77	1461195.82	40.5	28.64	28.02	30.0	40.5	-1.36	-11.86	PVC	4	5/31/94	ACH	10		Inspected April 2000; NPI
B	IR06	IR06MW59A1	A	452960.31	1461070.15	10.0	9.82	9.46	5.0	10.0	4.82	-0.18	PVC	4	12/14/00	HSA	10		Inspected August 2001; NPI
B	IR06	IR06MW59A2	A	452956.32	1461071.60	30.0	9.69	9.50	20.0	30.0	-10.31	-20.31	PVC	4	9/21/00	HSA	12		Inspected August 2001; NPI
B	IR06	IR06P30A	A	452920.00	1461092.00	17.0	10.39	10.12	7.0	17.0	3.39	-6.61	PVC	2	8/7/95	ACH	10		Could not locate August 2001.
B	IR06	IR06P54FB	A	452759.44	1460945.49	52.0	35.57	34.96	42.0	52.0	-6.43	-16.43	PVC	4	6/22/95	ACH	10		Inspected August 2001; NPI
B	IR06	IR25MW40A	A	452919.66	1461174.68	15.0	9.89	9.72	5.0	15.0	4.89	-5.11	PVC	4	9/21/00	HSA	12		Inspected August 2001; NPI
B	IR07	IR07MW19A	A	453874.18	1460508.90	16.0	10.03	9.56	6.0	16.0	4.03	-5.97	PVC	4	12/6/90	HSA	12		Inspected March 2000; NPI
B	IR07	IR07MW20A1	A	453944.26	1460379.24	24.0	10.26	9.26	6.0	24.0	4.26	-13.74	PVC	4	12/10/90	HSA	12		Inspected March 2000; vault repaired January 4, 2001
B	IR07	IR07MW20A2	A	453938.37	1460378.90	44.0	10.23	9.27	39.0	44.0	-28.77	-33.77	PVC	4	12/7/90	HSA	12	b	Decommissioned
B	IR07	IR07MW21A1	A	453895.47	1459762.25	16.0	12.93	14.68	6.0	16.0	6.93	-3.07	PVC	4	12/5/90	HSA	12	3/14/01	Decommissioned
B	IR07	IR07MW21A2	A	453898.24	1459758.30	34.0	13.24	14.42	29.0	34.0	-15.76	-20.76	PVC	4	12/4/90	HSA	12	3/14/01	Decommissioned
B	IR07	IR07MW23A	A	453693.82	1459476.14	17.0	16.40	15.76	7.0	17.0	9.40	-0.60	PVC	4	12/6/90	HSA	12		Inspected April 2000; NPI
B	IR07	IR07MW24A	A	453956.67	1459700.59	15.5	9.91	13.56	5.0	15.0	4.91	-5.09	PVC	4	5/4/99	HSA	10	2/26/01	Decommissioned
B	IR07	IR07MW25A	A	454016.43	1459635.38	18.5	8.70	11.91	3.0	18.0	5.70	-9.30	PVC	4	5/6/99	HSA	10	11/30/00	Decommissioned
B	IR07	IR07MW26A	A	453980.66	1460074.64	15.5	9.77	12.69	5.0	15.0	4.77	-5.23	PVC	4	5/4/99	HSA	10	3/14/01	Decommissioned
B	IR07	IR07MW27A	A	453649.86	1459864.33	21.5	16.42	16.15	11.0	21.0	5.42	-4.58	PVC	4	4/8/99	HSA	10		Inspected April 2000; NPI
B	IR07	IR07MW28A	A	453984.94	1459539.08	15.5	9.17	12.03	5.0	15.0	4.17	-5.83	PVC	4	5/11/99	HSA	10		Inspected April 2000; NPI
B	IR07	IR07MW93A	A	453502.4	1459168.3	30.0	17.1	18.75	20.0	30.0	-2.90	-12.90	PVC	2	6/19/01	HSA	8		New well installed by R&M. Inspected August 2001; NPI
B	IR07	IR07MW94A	A	453446.9	1459396.7	24.0	20.9	20.7	14.0	24.0	6.90	-3.10	PVC	2	6/19/01	HSA	8		New well installed by R&M. Inspected August 2001; NPI
B	IR07	IR07MW95A	A	453533.2	1459686.3	21.0	19.6	19.53	11.0	21.0	8.60	-1.40	PVC	2	6/20/01	HSA	8		New well installed by R&M. Inspected August 2001; NPI
B	IR07	IR07MWP-1	A	453827.39	1460384.54	19.0	9.85	9.87	4.0	19.0	5.85	-9.15	SS	2	9/5/86	HSA	8	7/23/98	Decommissioned

TABLE 4-1 (Continued)

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
B	IR07	IR07MWP-2	A	453930.86	1460411.98	19.0	10.04	9.77	4.0	19.0	6.04	-8.96	SS	2	9/5/86	HSA	8	7/23/98	Decommissioned
B	IR07	IR07MWS-1	A	453601.04	1460162.37	18.0	10.63	10.25	5.0	18.0	5.63	-7.37	SS	2	9/2/86	HSA	8	b	Decommissioned
B	IR07	IR07MWS-2	A	453860.98	1460286.15	15.5	10.09	12.71	5.5	15.5	4.59	-5.41	PVC	4	6/28/99	HSA	10		Inspected April 2000; NPI
B	IR07	IR07MWS-2D	A	453866.69	1460298.25	20.5	9.68	9.13	3.0	18.0	6.68	-8.32	SS	2	9/2/86	HSA	8	8/12/98	Decommissioned
B	IR07	IR07MWS-3	A	453983.55	1460068.55	20.0	10.31	9.75	5.0	20.0	5.31	-9.69	SS	2	9/3/86	HSA	8	8/19/98	Decommissioned
B	IR07	IR07MWS-4	A	453840.15	1459948.64	18.5	14.11	15.83	8.0	18.0	6.11	-3.90	PVC	4	4/8/99	HSA	10	3/22/01	Decommissioned
B	IR07	IR07MWS-4D	A	453864.34	1459924.22	21.0	13.25	13.22	6.0	21.0	7.25	-7.75	SS	2	9/4/86	HSA	8	7/23/98	Decommissioned
B	IR07	IR07P20A	A	453927.21	1460374.65	25.0	10.25	9.57	5.0	25.0	5.25	-14.75	PVC	2	1/29/92	HSA	8		Inspected August 2001; NPI
B	IR10	IR10MW12A	A	453434.25	1460715.61	18.0	9.70	9.08	3.0	18.0	6.70	-8.30	PVC	4	12/30/88	HSA	10		Vault repaired January 4, 2001
B	IR10	IR10MW13A1	A	453493.91	1460949.27	20.5	10.25	9.92	5.0	20.0	5.25	-9.75	PVC	4	12/22/88	HSA	10		Inspected March 2000; NPI
B	IR10	IR10MW13A2	A	453491.41	1460947.03	40.0	10.22	9.96	25.0	40.0	-14.78	-29.78	PVC	4	12/20/88	HSA	10		Inspected March 2000; requires redevelopment before resampling
B	IR10	IR10MW14A	A	453314.10	1461123.44	20.0	10.60	10.23	5.0	20.0	5.60	-9.40	PVC	4	1/4/89	HSA	11		Vault repaired January 4, 2001
B	IR10	IR10MW15A	A	453130.07	1460834.67	18.0	10.09	9.70	5.0	18.0	5.09	-7.91	PVC	4	12/29/88	HSA	10	10/15/98	Decommissioned
B	IR10	IR10MW28A	A	453331.55	1460886.65	17.0	14.14	13.57	7.0	17.0	7.14	-2.86	PVC	4	9/19/91	HSA	7		Vault repaired January 4, 2001
B	IR10	IR10MW29A1	A	453398.31	1461092.66	15.0	9.78	9.15	5.0	15.0	4.78	-5.23	PVC	4	9/19/91	HSA	11		Vault replaced August 3, 2001
B	IR10	IR10MW29A2	A	453405.99	1461098.08	58.6	9.69	9.04	48.6	58.6	-38.91	-48.91	PVC	4	9/18/91	HSA	11		Vault replaced January 14, 2000
B	IR10	IR10MW31A1	A	453615.90	1461025.80	17.0	10.55	10.34	7.0	17.0	3.55	-6.45	PVC	4	5/3/99	HSA	10		Inspected March 2000; NPI
B	IR10	IR10MW31A1D	A	453603.38	1461023.58	20.5	10.57	9.86	5.0	20.0	5.57	-9.43	PVC	4	12/13/93	ACH	10	10/12/98	Decommissioned
B	IR10	IR10MW31A2	A	453603.69	1461019.98	40.5	10.54	9.96	25.0	40.0	-14.46	-29.46	PVC	4	1/31/94	ACH	10	10/12/98	Decommissioned
B	IR10	IR10MW32A	A	453576.62	1460834.19	21.0	10.06	9.77	6.0	21.0	4.06	-10.94	PVC	4	3/17/94	HSA	10		Inspected March 2000; NPI
B	IR10	IR10MW33A	A	453449.25	1460845.00	15.5	10.43	10.17	5.5	15.5	4.93	-5.07	PVC	4	6/28/99	HSA	10		Inspected April 2000; NPI
B	IR10	IR10MW59A	A	453416.1	1460841.8	17.5	14.2	13.79	8.5	17.5	5.70	-3.30	PVC	4	3/16/01	HSA	10		New well installed by IT
B	IR10	IR10P13A	A	453504.27	1460967.72	20.0	10.47	9.83	5.0	20.0	5.47	-9.53	PVC	2	1/28/92	HSA	8		Inspected August 2001; NPI
B	IR10	IR10P13AA	A	453499.00	1460934.00	20.5	10.12	9.99	5.0	20.0	5.12	-9.88	PVC	2	8/8/95	HSA	8		Inspected August 2001; NPI
B	IR10	IR10P15A	A	453143.54	1460819.99	15.0	9.76	9.06	5.0	15.0	4.76	-5.24	PVC	2	1/27/92	HSA	8	10/14/98	Decommissioned
B	IR10	IR25MW37A	A	453205.58	1461207.98	16.0	10.39	10.09	7.0	16.0	3.39	-5.61	PVC	4	11/30/00	ARCH	10		Inspected August 2001; NPI
B	IR10	IR25MW37B	B	453200.21	1461204.00	23.0	10.41	10.21	20.0	23.0	-9.59	-12.59	PVC	4	10/19/00	ARCH	10		Inspected August 2001; NPI
B	IR18	IR18MW21A	A	453595.74	1459304.90	20.0	17.83	17.56	10.0	20.0	7.83	-2.18	PVC	4	5/6/99	HSA	8		Inspected April 2000; NPI
B	IR18	IR18MW21AD	A	453595.53	1459305.05	27.0	17.69	17.11	12.0	27.0	5.69	-9.31	PVC	4	4/20/93	ACH	10	8/12/98	Decommissioned
B	IR18	IR18MW22A	A	453556.55	1459572.98	27.0	18.80	18.11	12.0	27.0	6.80	-8.20	PVC	4	4/19/93	ACH	10	7/22/98	Decommissioned
B	IR18	IR18MW91A	A	453749.3	1459659.7	23.5	15.2	15.15	13.0	23.0	2.20	-7.80	PVC	2	6/20/01	HSA	8		New well installed by R&M. Inspected August 2001; NPI
B	IR18	IR18MW92A	A	453827.3	1459415.2	27.0	13.9	16.6	17.0	27.0	-3.10	-13.10	PVC	2	6/19/01	HSA	8		New well installed by R&M. Inspected August 2001; NPI
B	IR18	IR18MW100B	B	453579.54	1459329.10	47.0	18.25	17.94	40.0	45.0	-21.76	-26.76	PVC	4	6/26/98	ACH	14		Inspected April 2000; NPI
B	IR18	IR18MW101B	B	453573.70	1459432.00	45.0	18.96	18.89	37.0	42.0	-18.04	-23.04	PVC	4	6/24/98	ACH	14		Inspected April 2000; NPI
B	IR18	IR18MW200A	A	453615.58	1459217.80	33.0	25.34	26.96	18.0	33.0	7.34	-7.66	PVC	4	5/13/99	HSA	10		Well condition assessment pending
B	IR18	IR18P21A1	A	453588.53	1459299.65	27.0	17.77	17.52	12.0	27.0	5.77	-9.23	PVC	2	9/27/93	HSA	8	8/19/98	Decommissioned
B	IR18	IR18P21A2	A	453586.71	1459319.01	27.5	17.82	17.12	12.0	27.5	5.82	-9.68	PVC	2	9/27/93	HSA	8	8/12/98	Decommissioned
B	IR18	PA18MW09A	A	453628.25	1459405.47	25.0	18.03	17.66	10.0	25.0	8.03	-6.97	PVC	4	1/30/91	HSA	11		Inspected April 2000; NPI
B	IR20	IR20MW01A	A	453143.50	1461520.97	18.0	9.42	8.31	4.0	18.0	5.42	-8.58	PVC	4	5/14/93	CFA	6	1/4/98	Decommissioned
B	IR20	IR20MW06A	A	453248.66	1461586.86	23.0	10.40	9.85	8.0	23.0	2.40	-12.60	PVC	4	4/28/93	ACH	10	10/14/98	Decommissioned
B	IR20	IR20MW11A	A	453110.78	1461626.99	19.0	10.96	10.52	6.0	19.0	4.96	-8.04	PVC	4	5/11/93	ACH	10	10/14/98	Decommissioned
B	IR20	IR20MW17A	A	453190.62	1461540.19	22.0	10.90	10.51	7.0	22.0	3.90	-11.10	PVC	4	4/27/94	ACH	10		Inspected March 2000; NPI
B	IR23	IR23MW14A	A	454033.00	1460500.00	21.5	9.99	9.61	6.0	21.0	3.99	-11.01	PVC	4	8/1/95	ACH	10	7/23/98	Decommissioned
B	IR23	UT03MW10A	A	453569.46	1460259.39	15.0	11.02	10.60	5.0	14.5	6.02	-3.48	PVC	4	5/9/94	ACH	10		Inspected April 2000; NPI
B	IR23	UT03MW11A	A	453634.94	1460185.06	20.5	10.56	9.94	5.0	20.0	5.56	-9.44	PVC	4	5/19/94	ACH	10		Inspected April 2000; NPI
B	IR23	UT03MW12A	A	453575.93	1460331.93	21.5	10.72	10.10	6.0	21.0	4.72	-10.28	PVC	4	5/23/94	HSA	10		Inspected April 2000; NPI
B	IR23	UT03MW16A	A	453657.00	1460392.00	21.5	11.14	10.45	6.0	21.0	5.14	-9.86	PVC	4	10/16/95	ACH	10		Inspected March 2000; NPI
B	IR24	IR06MW40A	A	453012.98	1461127.73	20.5	10.60	10.08	7.0	20.5	3.60	-9.90	PVC	4	6/6/90	HSA	12		Inspected February 2001; vault repaired July 25, 2001
B	IR24	IR06MW44A	A	453083.82	1461187.35	15.0	10.26	9.81	5.0	15.0	5.26	-4.74	PVC	4	9/19/91	HSA	11		Inspected March 2000; NPI

TABLE 4-1 (Continued)

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
B	IR24	IR24MW04A	A	453384.64	1461476.66	16.0	9.20	11.16	6.0	16.0	3.20	-6.80	PVC	4	4/10/95	HSA	8	10/14/98	Decommissioned
B	IR24	IR25MW17A	A	453179.91	1461269.80	21.0	10.78	10.31	5.5	21.0	5.28	-10.22	PVC	4	5/19/94	ACH	10		Inspected March 2000; NPI
B	IR24	IR25MW38B	B	453194.38	1461285.90	34.0	10.72	10.44	30.0	34.0	-19.28	-23.28	PVC	4	11/13/00	ARCH	10		New well constructed by IT (November 2000). Inspected August 2001; NPI
B	IR24	IR25MW42B	B	453085.53	1461185.17	28.0	10.25	10.01	24.5	28.0	-14.25	-17.75	PVC	4	11/29/00	ARCH	10		New well constructed by IT (November 2000). Inspected August 2001; NPI
B	IR24	PA24MW01A	A	453756.60	1460910.10	26.0	9.42	10.12	6.0	26.0	3.42	-16.58	PVC	4	1/25/93	ACH	10		Inspected March 2000; NPI
B	IR24	PA24MW02A	A	453612.49	1461318.15	21.5	10.06	9.46	6.0	21.5	4.06	-11.45	PVC	4	1/22/93	ACH	10		Inspected March 2000; NPI
B	IR24	PA24MW03A	A	453434.65	1461548.13	15.0	10.65	10.09	5.0	15.0	5.65	-4.35	PVC	2	6/27/00	HSA	8	3/22/01	Decommissioned
B	IR24	PA24MW03AD	A	453439.27	1461553.01	26.0	10.56	9.97	6.0	26.0	4.56	-15.44	PVC	4	1/25/93	ACH	10	10/13/98	Decommissioned
B	IR26	IR26MW36A	A	453101.42	1461881.54	17.5	7.57	8.28	5.5	17.5	2.07	-9.93	PVC	4	9/29/94	ACH	10	b	Decommissioned
B	IR26	IR26MW40A	A	453255.18	1461821.88	26.5	10.48	9.89	6.0	26.0	4.48	-15.52	PVC	4	11/16/94	ACH	10		Inspected March 2000; NPI
B	IR26	IR26MW41A	A	453170.16	1461730.13	21.5	10.55	10.15	6.0	21.0	4.55	-10.45	PVC	4	11/11/94	ACH	10		Inspected March 2000; NPI
B	IR26	IR26MW42A	A	453201.00	1461923.00	21.5	8.88	8.18	6.0	21.0	2.88	-12.12	PVC	4	10/13/95	ACH	10	2/28/01	Decommissioned
B	IR26	IR26MW43A	A	453117.00	1461949.00	16.5	7.99	7.09	6.0	16.0	1.99	-8.01	PVC	4	10/13/95	ACH	10		Inspected March 2000; NPI
B	IR26	IR26MW44A	A	452993.00	1461781.00	14.0	8.77	8.25	6.0	13.0	2.77	-4.24	PVC	4	10/13/95	ACH	10		Inspected March 2000; NPI
B	IR26	IR26MW45A	A	453031.99	1462451.80	16.5	8.47	8.28	6.5	16.5	1.97	-8.03	PVC	4	5/12/99	HSA	10	2/28/01	Decommissioned
B	IR46	IR46MW37A	A	453313.79	1461359.15	21.0	10.50	9.58	6.0	21.0	4.50	-10.50	PVC	4	3/17/94	HSA	10		Inspected March 2000; NPI
B	IR46	IR46MW38A	A	453446.11	1461236.22	21.0	10.27	9.78	6.0	21.0	4.27	-10.73	PVC	4	3/16/94	HSA	10		Inspected March 2000; NPI
B	IR46	IR46MW39A	A	453696.82	1461196.22	21.0	10.04	9.75	6.0	21.0	4.04	-10.96	PVC	4	3/18/94	HSA	10		Inspected March 2000; NPI
B	IR46	IR46MW39A2	A	453708.76	1461196.60	31.5	10.00	9.32	26.0	31.0	-16.00	-21.00	PVC	4	7/11/94	ACH	10		Inspected March 2000; NPI
B	IR46	IR46MW39A3	A	453700.83	1461207.19	41.5	10.11	9.47	36.0	41.0	-25.89	-30.89	PVC	4	7/12/94	ACH	10		Inspected March 2000; NPI
B	IR46	IR46MW40A	A	453506.56	1461448.48	21.0	10.13	9.39	5.5	21.0	4.63	-10.87	PVC	4	3/28/94	HSA	10		Inspected March 2000; NPI
B	IR46	IR46MW40A2	A	453513.31	1461445.00	31.5	9.99	9.33	26.0	31.0	-16.01	-21.01	PVC	4	7/13/94	HSA	10	10/14/98	Decommissioned
B	IR46	IR46MW40A3	A	453505.55	1461455.47	41.0	9.97	9.28	36.0	41.0	-26.03	-31.03	PVC	4	7/14/94	ACH	10		Inspected March 2000; NPI
B	IR46	IR46MW41A	A	453315.08	1461733.30	21.5	10.23	9.54	6.0	21.0	4.23	-10.77	PVC	4	5/19/94	ACH	10		Inspected March 2000; NPI
B	IR46	IR46MW42A	A	453841.59	1461050.49	21.5	10.21	9.53	6.0	21.0	4.21	-10.79	PVC	4	5/19/94	ACH	10	10/13/98	Decommissioned
B	IR46	IR46MW43A	A	453865.93	1460868.23	21.0	9.48	8.98	6.0	21.0	3.48	-11.52	PVC	4	5/18/94	ACH	10		Inspected March 2000; NPI
B	IR46	IR46MW46A	A	453729.00	1461225.00	21.5	10.35	9.61	6.0	21.0	4.35	-10.65	PVC	4	10/12/95	ACH	10		Inspected March 2000; NPI
B	IR46	IR46MW47A	A	453641.00	1461337.00	21.5	10.22	9.69	6.0	21.0	4.22	-10.78	PVC	4	10/12/95	ACH	10		Inspected March 2000; NPI
B	IR46	IR46MW48A	A	453542.00	1461472.00	21.5	9.48	8.89	6.0	21.0	3.48	-11.52	PVC	4	10/12/95	ACH	10		Inspected March 2000; NPI
B	IR46	IR46P38AA	A	453435.01	1461253.16	31.5	10.04	10.68	6.0	31.0	4.04	-20.96	PVC	2	9/19/94	ARCH	10		Inspected August 2001; NPI
B	IR46	IR46P38AB	A	453445.96	1461259.27	21.5	10.60	10.75	6.0	21.0	4.60	-10.40	PVC	2	9/20/94	ARCH	10		Inspected August 2001; NPI
B	IR50	PA50MW01A	A	453658.20	1460792.22	16.2	9.73	9.18	6.0	16.2	3.73	-6.47	PVC	4	3/8/93	ACH	10		Inspected February 2001; vault replaced August 1, 2001
B	IR50	PA50MW02A	A	452949.76	1461934.39	16.0	8.41	7.80	6.0	16.0	2.41	-7.59	PVC	4	3/8/93	ACH	10		Inspected March 2000; NPI
B	IR60	IR60MW04A	A	453962.00	1460602.00	22.0	9.78	9.34	6.0	21.0	3.78	-11.22	PVC	4	7/31/95	ACH	10	7/23/98	Decommissioned
B	IR60	IR60MW08A	A	453842.00	1460745.00	21.5	9.74	9.40	6.0	21.0	3.74	-11.26	PVC	4	7/31/95	HSA	10		Inspected March 2000; NPI
B	IR60	IR60MW10A	A	453836.00	1460639.00	21.5	9.87	9.11	6.0	21.0	3.87	-11.13	PVC	4	8/9/95	HSA	10	8/27/98	Decommissioned
B	IR61	IR61MW04A	A	453442.00	1460567.00	21.5	10.65	10.35	6.0	21.0	4.65	-10.35	PVC	4	7/27/95	HSA	10		Inspected February 2001; vault replaced July 31, 2001
B	IR61	IR61MW05A	A	453484.00	1460621.00	21.5	10.51	10.11	6.0	21.0	4.51	-10.49	PVC	4	7/28/95	HSA	10		Inspected April 2000; NPI
B	IR62	IR62MW07A	A	453364.00	1460435.00	21.5	10.46	10.20	6.5	21.5	3.96	-11.04	PVC	4	8/22/95	HSA	10		Inspected February 2001; vault replaced July 31, 2001
B	IR62	IR62MW08A	A	453176.00	1460458.00	17.0	10.89	10.35	6.0	16.0	4.89	-5.11	PVC	4	8/23/95	HSA	10		Inspected August 2001; NPI
B	IR62	UT02MW15A	A	453338.16	1460317.32	19.5	11.18	12.57	4.5	19.5	6.68	-8.32	PVC	4	5/10/94	ACH	10		Inspected April 2000; NPI
B	IR62	UT02MW16A	A	453352.53	1460260.00	20.0	10.66	9.91	4.5	19.5	6.16	-8.84	PVC	4	5/18/94	ACH	10	1/4/98	Decommissioned
B	IR62	UT02MW17A	A	453448.18	1460276.85	15.5	9.44	10.12	5.0	15.0	4.44	-5.56	PVC	4	5/18/94	ACH	10		Vault replaced 8/3/01; requires redevelopment before resampling.
C	IR25	IR06MW34A	A	452900.14	1461271.42	12.0	10.95	10.37	7.0	12.0	3.95	-1.05	PVC	4	6/7/90	HSA	12		Inspected March 2000; NPI
C	IR25	IR06MW41A	A	452965.42	1461190.12	17.0	10.33	9.78	7.0	17.0	3.33	-6.67	PVC	4	6/5/90	HSA	12		Inspected March 2000; NPI; vault repaired January 4, 2001
C	IR25	IR06MW42A	A	452872.19	1461317.85	13.5	12.33	11.89	8.5	13.5	3.83	-1.17	PVC	4	6/5/90	HSA	12		Inspected March 2000; NPI; vault repaired January 4, 2001
C	IR25	IR06MW45A	A	453071.69	1461364.35	14.0	10.57	9.89	4.0	14.0	6.57	-3.43	PVC	4	9/17/91	HSA	11		Inspected March 2000; redeveloped by R&M (June/July 2000)
C	IR25	IR25MW11A	A	453039.62	1461215.62	20.0	11.06	10.45	5.0	20.0	6.06	-8.94	PVC	2	11/24/93	CFA	8		Inspected March 2000; well contains product; borehole diameter in question

TABLE 4-1 (Continued)

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
C	IR25	IR25MW15A1	A	453079.24	1461220.20	13.5	7.69	7.84	3.5	13.5	4.19	-5.81	PVC	2	6/8/94	HSA	8		Inspected March 2000; NPI
C	IR25	IR25MW15A2	A	453077.27	1461223.98	30.0	7.17	7.38	20.0	30.0	-12.83	-22.83	PVC	2	5/23/94	HSA	8		Inspected March 2000; NPI
C	IR25	IR25MW16A	A	452978.43	1461319.09	21.5	11.50	11.02	6.0	21.0	5.50	-9.50	PVC	4	5/23/94	HSA	10		Inspected March 2000; NPI
C	IR25	IR25MW18A	A	453100.59	1461221.47	16.0	10.73	10.46	11.0	16.0	-0.27	-5.27	PVC	0.75	12/18/97	DPT	2.5		Inspected March 2000; NPI
C	IR25	IR25MW19A	A	453088.54	1461210.92	16.0	10.70	10.51	11.0	16.0	-0.30	-5.30	PVC	0.75	12/18/97	DPT	2.5		Inspected March 2000; NPI
C	IR25	IR25MW20A	A	453066.29	1461199.09	13.0	10.75	10.48	8.0	13.0	2.75	-2.25	PVC	0.75	12/18/97	DPT	2.5		Inspected March 2000; NPI
C	IR25	IR25MW22A	A	453018.72	1461201.82	11.0	11.45	11.19	6.0	11.0	5.45	0.45	PVC	0.75	12/18/97	DPT	2.5		Inspected March 2000; Well contains product.
C	IR25	IR25MW39A	A	453034.39	1461259.39	14.0	11.48	11.21	7.0	14.0	4.48	-2.52	PVC	4	12/21/00	HSA	10		New well constructed by IT (December 2000). Inspected August 2001; NPI
C	IR25	IR25MW39B	B	453025.27	1461272.67	25.0	11.48	11.25	19.0	25.0	-7.52	-13.52	PVC	4	12/12/00	ARCH	10		New well constructed by IT (December 2000). Inspected August 2001; NPI
C	IR25	IR25MW41A	A	453073.47	1461371.58	26.5	10.52	10.08	21.5	26.5	-10.98	-15.98	PVC	4	9/20/00	HSA	12		New well constructed by IT (September 2000). Inspected August 2001; NPI
C	IR25	IR25MW900B	B	453063.382	1461213.98	28.0	11.41	11.02	19.0	28.0	-7.59	-16.59	PVC	4	12/15/00	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR25	IR25MW901B	B	453066.514	1461216.05	28.0	11.40	10.98	19.0	28.0	-7.60	-16.60	PVC	4	12/15/00	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR25	IR25MW902B	B	453067.941	1461217.23	28.0	11.42	11.02	18.0	28.0	-6.58	-16.58	PVC	4	12/15/00	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR25	IR25MW903B	B	453090.826	1461215.8	29.0	10.81	10.48	24.0	29.0	-13.19	-18.19	PVC	4	12/15/00	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR25	IR25MW904B	B	453100.738	1461223.07	27.5	10.75	10.43	22.0	27.5	-11.25	-16.75	PVC	4	12/15/00	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR25	IR25MW905B	B	453071.055	1461226.05	17.6	8.03	7.63	10.6	17.6	-2.57	-9.57	PVC	2	2/22/01	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28IW901A	A	452156.812	1462596.55	15.0	9.05	8.71	10.0	15.0	-0.95	-5.95	PVC	6	1/22/01	HSA	12		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28IW902A	A	452182.496	1462584.32	20.0	9.00	8.62	10.0	20.0	-1.00	-11.00	PVC	6	1/22/01	HSA	12		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28IW903A	A	452154.161	1462563.82	19.5	9.04	8.49	9.5	19.5	-0.46	-10.46	PVC	6	1/22/01	HSA	12		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28IW938F	Bedrock	451853.729	1461771.78	20.5	9.06	8.90	10.4	20.4	-1.34	-11.34	SS	6	1/30/01	HSA	12		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28IW939F	Bedrock	451874.502	1461760.42	20.5	9.04	8.94	10.5	20.5	-1.46	-11.46	SS	6	1/31/01	HSA	10		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28IW940F	Bedrock	451856.555	1461751.25	20.5	9.05	8.75	10.5	20.5	-1.45	-11.45	SS	6	2/2/01	HSA	12		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW122A	A	452442.31	1463091.72	21.5	7.86	7.48	6.0	21.5	1.86	-13.64	PVC	4	04/13/94	HSA	10		Inspected March 2000; vault repaired January 3, 2001
C	IR28	IR28MW123A	A	452247.64	1463010.31	21.0	8.31	8.09	6.0	21.0	2.31	-12.69	PVC	4	04/15/94	HSA	10		Inspected March 2000; vault replaced November 13, 2000
C	IR28	IR28MW124A	A	452619.68	1463039.01	21.0	7.82	7.14	5.5	21.0	2.32	-13.18	PVC	4	05/05/94	ACH	10		Inspected March 2000; vault repaired January 3, 2001
C	IR28	IR28MW125A	A	452599.43	1462807.72	17.5	8.54	7.74	5.5	17.5	3.04	-8.96	PVC	4	05/06/94	ACH	10		Inspected March 2000; vault repaired January 3, 2001
C	IR28	IR28MW126A	A	452539.64	1462590.14	21.0	8.34	7.76	5.5	21.0	2.84	-12.66	PVC	4	05/04/94	ACH	10		Inspected March 2000; vault repaired January 4, 2001
C	IR28	IR28MW127A	A	452452.55	1462457.87	21.5	8.45	7.63	6.0	21.5	2.45	-13.05	PVC	4	05/02/94	ACH	10		Inspected February 2001; vault replaced July 30, 2001
C	IR28	IR28MW128A	A	452260.48	1462547.94	17.5	8.56	8.11	5.5	17.5	3.06	-8.94	PVC	4	05/03/94	ACH	10		Inspected March 2000; vault replaced November 13, 2000
C	IR28	IR28MW129A	A	452229.39	1462433.10	21.5	9.45	8.83	6.0	21.5	3.45	-12.05	PVC	4	05/03/94	ACH	10		Inspected August 2001; well contains product; vault requires replacement
C	IR28	IR28MW136A	A	452390.17	1462774.94	15.5	8.09	7.55	5.0	15.5	3.09	-7.41	PVC	4	05/24/94	HSA	12		Inspected April 2000; NPI
C	IR28	IR28MW140F	Bedrock	452634.69	1463039.77	44.5	8.16	7.61	29.0	44.5	-20.84	-36.34	PVC	4	06/23/94	ACH	10		Inspected March 2000; NPI
C	IR28	IR28MW149A	A	452009.75	1462351.34	21.5	9.53	8.92	6.0	21.5	3.53	-11.97	PVC	4	05/05/94	ACH	10		Inspected March 2000; NPI
C	IR28	IR28MW150A	A	452137.62	1462857.71	21.5	8.37	7.87	6.0	21.5	2.37	-13.13	PVC	4	05/11/94	ACH	10		Inspected March 2000; vault repaired February 2, 2001
C	IR28	IR28MW151A	A	452169.83	1462589.71	21.5	9.07	8.57	6.0	21.5	3.07	-12.43	PVC	4	06/07/94	ACH	10		Inspected August 2001; vault repaired August 1, 2001
C	IR28	IR28MW155A	A	452204.20	1462424.04	21.5	9.08	8.57	6.0	21.5	3.08	-12.42	PVC	4	05/24/94	HSA	12		Inspected March 2000; vault replaced November 14, 2000
C	IR28	IR28MW169A	A	452128.38	1462258.98	21.5	10.12	9.69	6.0	21.5	4.12	-11.38	PVC	4	05/25/94	HSA	12		Inspected February 2001; needs replacement cap and rubber seal
C	IR28	IR28MW170A	A	452221.24	1462783.80	20.5	9.09	8.76	5.4	20.5	3.69	-11.41	PVC	4	06/22/94	HSA	10.25		Inspected August 2001; vault repaired August 1, 2001
C	IR28	IR28MW171A	A	451820.32	1462451.58	21.5	7.21	6.67	6.0	21.5	1.21	-14.29	PVC	4	05/27/94	ACH	10		Inspected March 2000; vault replaced November 13, 2000
C	IR28	IR28MW172F	Bedrock	452077.73	1461964.61	67.5	9.47	8.57	57.0	67.0	-47.53	-57.53	PVC	4	11/08/94	ACH	10		Inspected March 2000; NPI
C	IR28	IR28MW173B	B	452216.07	1462605.49	60.0	8.96	8.06	49.5	59.5	-40.54	-50.54	PVC	4	11/01/94	ACH	10		Inspected August 2001; NPI
C	IR28	IR28MW188F	Bedrock	452231.64	1461506.05	22.0	10.42	9.64	8.5	22.0	1.92	-11.58	PVC	4	06/02/94	ACH	10		Inspected March 2000; NPI
C	IR28	IR28MW189F	Bedrock	452297.76	1461747.42	17.5	9.51	8.87	7.5	17.5	2.01	-7.99	PVC	4	06/03/94	ACH	10		Inspected March 2000; NPI
C	IR28	IR28MW190F	Bedrock	452102.47	1461715.85	16.3	10.26	10.06	13.0	16.3	-2.74	-6.04	PVC	4	06/01/94	HSA	10		Inspected March 2000; NPI
C	IR28	IR28MW200A	A	451703.70	1461977.64	16.0	8.70	8.28	5.5	16.0	3.20	-7.30	PVC	4	05/25/94	HSA	12		Inspected March 2000; NPI
C	IR28	IR28MW201F	Bedrock	451708.35	1461993.94	35.5	8.72	8.04	25.0	35.0	-16.28	-26.28	PVC	4	11/17/94	ACH	10		Inspected March 2000; NPI
C	IR28	IR28MW211F	Bedrock	451865.20	1461768.85	16.5	9.08	8.57	6.0	16.5	3.08	-7.42	PVC	4	06/03/94	HSA	10.25		Inspected April 2000; NPI; borehole diameter in question
C	IR28	IR28MW216F	Bedrock	452033.12	1461799.63	28.5	9.08	8.38	18.0	28.5	-8.92	-19.42	PVC	4	06/06/94	ACH	10		Inspected February 2001; vault replaced July 27, 2001

TABLE 4-1 (Continued)

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
C	IR28	IR28MW217A	A	452069.68	1461929.39	20.0	9.48	8.98	6.0	20.0	3.48	-10.52	PVC	4	05/26/94	HSA	10		Inspected February 2001; vault replaced July 27, 2001; borehole diameter in question
C	IR28	IR28MW255F	Bedrock	452458.44	1462459.54	55.5	8.37	7.83	40.0	55.5	-31.63	-47.13	PVC	4	06/23/94	ACH	10		Inspected March 2000; rim of vault chipped; no immediate repair needed
C	IR28	IR28MW268A	A	452518.00	1462440.00	21.5	8.38	7.90	6.0	21.0	2.38	-12.62	PVC	4	10/17/95	ACH	10		Inspected March 2000; vault repaired February 6, 2001
C	IR28	IR28MW269A	A	452687.00	1463058.00	19.5	8.63	7.84	4.0	19.0	4.63	-10.37	PVC	4	10/18/95	ACH	10		Inspected March 2000; NPI
C	IR28	IR28MW270A	A	452251.00	1463116.00	21.5	8.32	7.61	6.0	21.0	2.32	-12.68	PVC	4	10/18/95	ACH	10		Inspected March 2000; vault repaired January 3, 2001
C	IR28	IR28MW271A	A	451900.00	1463030.00	21.5	7.78	7.06	6.0	21.0	1.78	-13.22	PVC	4	10/19/95	ACH	10		Inspected March 2000; vault repaired February 6, 2001
C	IR28	IR28MW272A	A	451571.00	1461950.00	12.0	8.49	7.85	6.5	11.5	1.99	-3.01	PVC	4	10/19/95	ACH	10		Inspected March 2000; vault repaired February 2, 2001
C	IR28	IR28MW273F	Bedrock	451850.00	1461710.00	20.8	9.10	9.01	5.5	20.5	3.60	-11.40	PVC	2	10/26/95	HSA	8	b	Decommissioned
C	IR28	IR28MW275F	Bedrock	451892.00	1461746.00	12.3	9.00	8.62	7.0	12.0	2.00	-3.00	PVC	2	10/23/95	HSA	4		Inspected March 2000; NPI
C	IR28	IR28MW286A	A	452226.00	1462036.00	11.5	10.21	9.81	6.0	11.0	4.21	-0.79	PVC	4	09/21/95	HSA	10		Inspected March 2000; NPI
C	IR28	IR28MW287A	A	452342.00	1462012.00	10.5	9.93	9.31	5.0	10.0	4.93	-0.07	PVC	4	09/21/95	HSA	10		Inspected February 2001; vault replaced July 30, 2001
C	IR28	IR28MW290A	A	451958.00	1462082.00	21.5	8.58	8.14	6.0	21.0	2.58	-12.42	PVC	4	09/19/95	HSA	10		Inspected August 2001; NPI
C	IR28	IR28MW293A	A	451625.00	1462268.00	21.5	8.32	7.50	6.0	21.0	2.32	-12.68	PVC	4	09/20/95	HSA	10		Inspected February 2001; may require vault repair and replacement lock
C	IR28	IR28MW294A	A	451611.00	1462222.00	21.5	8.43	7.78	6.0	21.0	2.43	-12.57	PVC	4	10/02/95	ACH	10		Inspected March 2000; vault repaired January 9, 2001
C	IR28	IR28MW295A	A	451636.00	1462314.00	21.5	8.36	7.62	6.0	21.0	2.36	-12.64	PVC	4	10/02/95	HSA	10		Inspected March 2000; vault repaired January 8, 2001
C	IR28	IR28MW297A	A	451590.00	1462275.00	21.5	8.36	7.68	6.0	21.0	2.36	-12.64	PVC	4	10/18/95	ACH	10		Inspected March 2000; vault repaired February 6, 2001
C	IR28	IR28MW298A	A	451627.00	1461779.00	10.0	8.44	8.04	4.5	9.5	3.94	-1.06	PVC	4	01/08/96	ACH	10		Inspected March 2000; vault repaired January 8, 2001
C	IR28	IR28MW299B	B	452198.00	1461918.00	21.5	9.91	9.60	6.0	21.0	3.91	-11.09	PVC	2	02/05/96	HSA	12		Inspected March 2000; NPI
C	IR28	IR28MW300F	Bedrock	452187.00	1461775.00	21.5	9.88	9.67	6.0	21.0	3.88	-11.12	PVC	4	02/05/96	ARCH	10		Inspected March 2000; vault repaired February 6, 2001
C	IR28	IR28MW308A	A	452441.00	1462277.00	16.5	8.20	7.63	6.0	16.0	2.20	-7.80	PVC	4	03/27/96	ARCH	12		Inspected March 2000; vault repaired February 5, 2001
C	IR28	IR28MW309B	B	452005.00	1462349.00	55.0	9.53	9.09	39.5	54.5	-29.97	-44.97	PVC	4	03/28/96	ARCH	12		Inspected March 2000; redeveloped by R&M (June/July 2000); vault repaired January 3, 2001
C	IR28	IR28MW310F	Bedrock	451895.00	1461821.00	36.5	8.40	7.88	26.0	36.0	-17.60	-27.60	PVC	4	04/01/96	ARCH	12		Inspected March 2000; vault repaired January 4, 2001
C	IR28	IR28MW311A	A	451890.00	1461825.00	19.5	8.35	8.02	4.0	19.0	4.35	-10.65	PVC	4	04/01/96	ACH	12		Inspected March 2000; vault repaired January 4, 2001
C	IR28	IR28MW312F	Bedrock	451700.00	1461874.00	19.5	8.78	8.45	9.0	19.0	-0.22	-10.22	PVC	4	04/02/96	ARCH	12		Inspected March 2000; NPI
C	IR28	IR28MW313F	Bedrock	452317.00	1461416.00	25.5	9.78	12.17	10.0	25.0	-0.22	-15.22	PVC	4	04/03/96	ARCH	12		Inspected March 2000; NPI
C	IR28	IR28MW314B	B	452393.00	1462784.00	25.5	8.82	8.68	20.0	25.0	-11.18	-16.18	PVC	4	04/24/96	ACH	10		Inspected March 2000; NPI
C	IR28	IR28MW324A	A	452435.66	1462693.77	13.0	9.01	8.79	8.0	13.0	1.01	-4.00	PVC	0.75	12/16/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW325A	A	452455.34	1462758.54	13.0	9.04	8.83	8.0	13.0	1.04	-3.96	PVC	0.75	12/16/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW326A	A	452471.27	1462820.35	13.0	9.03	8.75	8.0	13.0	1.03	-3.97	PVC	0.75	12/17/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW327A	A	452411.16	1462712.65	13.0	9.05	8.73	8.0	13.0	1.05	-3.95	PVC	0.75	12/16/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW328A	A	452417.33	1462760.47	13.0	8.32	8.04	8.0	13.0	0.32	-4.68	PVC	0.75	12/16/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW329A	A	452426.52	1462787.59	13.0	8.18	7.78	8.0	13.0	0.18	-4.82	PVC	0.75	12/15/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW330A	A	452390.28	1462694.96	13.0	9.03	8.78	8.0	13.0	1.03	-3.97	PVC	0.75	12/16/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW331A	A	452401.49	1462735.60	13.0	8.35	7.97	8.0	13.0	0.35	-4.65	PVC	0.75	12/15/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW333A	A	452437.19	1462871.05	13.0	9.04	8.71	8.0	13.0	1.04	-3.96	PVC	0.75	--	DPT	2.5		Inspected March 2000; NPI; no date on boring log
C	IR28	IR28MW334A	A	452401.86	1462774.85	13.0	9.00	8.78	8.0	13.0	1.00	-4.00	PVC	0.75	12/15/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW335A	A	452417.88	1462840.74	13.0	9.07	8.87	8.0	13.0	1.07	-3.93	PVC	0.75	12/17/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW336A	A	452398.27	1462804.94	13.0	8.94	8.55	8.0	13.0	0.94	-4.06	PVC	0.75	12/16/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW337A	A	452372.94	1462719.25	13.0	9.04	8.77	8.0	13.0	1.04	-3.96	PVC	0.75	12/16/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW338A	A	452340.47	1462713.27	13.0	9.04	8.83	8.0	13.0	1.04	-3.96	PVC	0.75	12/17/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW339A	A	452343.29	1462783.78	13.0	8.76	8.47	8.0	13.0	0.76	-4.24	PVC	0.75	12/17/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW340A	A	452360.34	1462847.94	13.0	8.89	8.65	8.0	13.0	0.89	-4.11	PVC	0.75	12/17/97	DPT	2.5		Inspected March 2000; NPI
C	IR28	IR28MW341F	Bedrock	451863.40	1461762.50	17.0	9.06	8.89	13.5	17.0	-4.44	-7.94	PVC	2	12/16/97	HSA	8		Inspected April 2000; NPI
C	IR28	IR28MW342F	Bedrock	451868.64	1461745.72	15.0	9.02	8.66	8.0	15.0	1.02	-5.98	PVC	2	12/16/97	HSA	8		Inspected April 2000; NPI
C	IR28	IR28MW393F	Bedrock	451883.47	1461836.14	59.3	8.22	8.07	56.5	59.3	-48.28	-51.03	PVC	4	10/31/00	ARCH	10		New well constructed by IT (October 2000). Inspected August 2001; NPI
C	IR28	IR28MW394A	A	451865.74	1462091.87	11.0	9.34	9.26	5.0	11.0	4.34	-1.66	PVC	4	12/5/00	ARCH	10		New well constructed by IT (December 2000). Inspected August 2001; NPI
C	IR28	IR28MW394B	B	451857.97	1462092.93	54.5	9.40	9.02	45.0	54.5	-35.60	-45.10	PVC	4	10/20/00	ARCH	10		New well constructed by IT (October 2000). Inspected August 2001; NPI

TABLE 4-1 (Continued)

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
C	IR28	IR28MW395F	Bedrock	452069.61	1461921.34	51.5	9.38	9.12	47.5	51.5	-38.12	-42.12	PVC	4	11/15/00	ARCH	10		New well constructed by IT (November 2000). Inspected August 2001; NPI
C	IR28	IR28MW396A	A	452136.33	1462148.78	11.5	9.31	8.99	5.0	11.5	4.31	-2.19	PVC	4	12/6/00	ARCH	10		New well constructed by IT (December 2000). Inspected August 2001; NPI
C	IR28	IR28MW396B	B	452138.80	1462142.58	42.0	9.24	9.09	32.5	42.0	-23.26	-32.76	PVC	4	10/16/00	ARCH	10		New well constructed by IT (October 2000). Inspected August 2001; needs replacement well plug
C	IR28	IR28MW397A	A	452310.07	1461984.73	8.0	9.46	9.13	3.0	8.0	6.46	1.46	PVC	4	9/25/00	HSA	12		New well constructed by IT (September 2000); vault repaired August 1, 2001
C	IR28	IR28MW397B	B	452311.84	1461998.79	37.0	9.64	9.37	33.5	37.0	-23.86	-27.36	PVC	4	10/25/00	ARCH	10		New well constructed by IT (October 2000); vault repaired August 1, 2001
C	IR28	IR28MW398A	A	452417.97	1462145.19	9.0	9.54	9.31	5.0	9.0	4.54	0.54	PVC	4	9/22/00	HSA	12		New well constructed by IT (September 2000); vault repaired August 1, 2001; needs replacement lock and well plug
C	IR28	IR28MW398B	B	452424.21	1462151.68	43.0	9.40	8.92	38.5	43.0	-29.10	-33.60	PVC	4	11/21/00	ARCH	10		New well constructed by IT (November 2000); vault repaired August 1, 2001; needs replacement rubber seal
C	IR28	IR28MW399B	B	452328.33	1462779.65	40.5	8.17	7.82	36.5	40.5	-28.33	-32.33	PVC	4	11/2/00	ARCH	10		New well constructed by IT (November 2000). Inspected August 2001; NPI
C	IR28	IR28MW400B	B	452229.69	1462804.12	28.0	9.09	8.88	25.0	28.0	-15.91	-18.91	PVC	4	12/28/00	ARCH	10		New well constructed by IT (December 2000). Inspected August 2001; NPI
C	IR28	IR28MW401B	B	452323.26	1462527.70	61.0	8.77	8.58	57.0	60.8	-48.23	-51.98	PVC	4	11/8/00	ARCH	10		New well constructed by IT (November 2000). Inspected August 2001; NPI
C	IR28	IR28MW402F	Bedrock	451885.26	1461842.27	43.0	8.16	7.88	41.0	43.0	-32.84	-34.84	PVC	4	12/1/00	ARCH	10		New well constructed by IT (December 2000). Inspected August 2001; NPI
C	IR28	IR28MW909A	A	452344.485	1461866.15	16.0	9.18	8.89	7.0	16.0	2.18	-6.82	PVC	4	1/12/01	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW910A	A	452345.657	1461874.71	25.0	9.16	8.93	19.0	25.0	-9.84	-15.84	PVC	4	1/12/01	HSA	11		New well installed by IT
C	IR28	IR28MW911A	A	452346.42	1461861.54	15.0	9.16	8.94	7.0	15.0	2.16	-5.84	PVC	4	1/12/01	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW912A	A	452340.394	1461856.07	25.0	9.22	8.85	18.0	25.0	-8.78	-15.78	PVC	4	1/10/01	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW913A	A	452324.079	1461852.04	20.0	9.32	8.99	18.0	20.0	-8.68	-10.68	PVC	4	1/10/01	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW914A	A	452331.264	1461883.76	17.0	9.68	9.45	10.0	17.0	-0.32	-7.32	PVC	4	1/12/01	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW916A	A	452154.269	1462609.59	19.0	9.17	8.80	10.0	19.0	-0.83	-9.83	PVC	4	12/21/00	HSA	10		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW918A	A	452151.689	1462598.74	32.5	9.12	8.81	24.0	32.5	-14.88	-23.38	PVC	4	12/21/00	HSA	10		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW919A	A	452173.43	1462603.18	20.0	8.99	8.63	10.0	20.0	-1.01	-11.01	PVC	4	1/9/01	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW920A	A	452155.587	1462570.14	17.8	9.01	8.62	10.0	17.8	-0.99	-8.79	PVC	4	1/9/01	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW921A	A	452176.349	1462576.82	20.0	9.01	8.67	10.0	20.0	-0.99	-10.99	PVC	4	1/9/01	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW930A	A	452153.203	1462557.52	19.0	9.04	8.70	10.0	19.0	-0.96	-9.96	PVC	4	1/9/01	HSA	11		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW932F	Bedrock	451878.241	1461757.32	30.0	9.04	8.76	27.0	30.0	-17.96	-20.96	PVC	4	1/16/01	HSA	8.5		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW933F1	Bedrock	451848.333	1461773.15	10.0	9.04	8.72	9.5	10.0	-0.46	-0.96	POLY	1.7	1/18/01	HSA	8.5		New well installed by IT; multilevel well. Inspected August 2001; NPI
C	IR28	IR28MW933F2	Bedrock	451848.333	1461773.15	15.0	9.04	8.72	14.5	15.0	-5.46	-5.96	POLY	1.7	1/18/01	HSA	8.5		New well installed by IT; multilevel well. Inspected August 2001; NPI
C	IR28	IR28MW933F3	Bedrock	451848.333	1461773.15	20.0	9.04	8.72	19.5	20.0	-10.46	-10.96	POLY	1.7	1/18/01	HSA	8.5		New well installed by IT; multilevel well. Inspected August 2001; NPI
C	IR28	IR28MW933F4	Bedrock	451848.333	1461773.15	25.0	9.04	8.72	24.5	25.0	-15.46	-15.96	POLY	1.7	1/18/01	HSA	8.5		New well installed by IT; multilevel well. Inspected August 2001; NPI
C	IR28	IR28MW933F5	Bedrock	451848.333	1461773.15	30.3	9.04	8.72	29.5	30.0	-20.46	-20.96	POLY	1.7	1/18/01	HSA	8.5		New well installed by IT; multilevel well. Inspected August 2001; NPI
C	IR28	IR28MW934F1	Bedrock	451853.685	1461747.7	10.0	9.05	8.80	9.5	10.0	-0.45	-0.95	POLY	1.7	1/19/01	HSA	8.5		New well installed by IT; multilevel well. Inspected August 2001; NPI
C	IR28	IR28MW934F2	Bedrock	451853.685	1461747.7	15.0	9.05	8.80	14.5	15.0	-5.45	-5.95	POLY	1.7	1/19/01	HSA	8.5		New well installed by IT; multilevel well. Inspected August 2001; NPI
C	IR28	IR28MW934F3	Bedrock	451853.685	1461747.7	20.0	9.05	8.80	19.5	20.0	-10.45	-10.95	POLY	1.7	1/19/01	HSA	8.5		New well installed by IT; multilevel well. Inspected August 2001; NPI
C	IR28	IR28MW934F4	Bedrock	451853.685	1461747.7	25.0	9.05	8.80	24.5	25.0	-15.45	-15.95	POLY	1.7	1/19/01	HSA	8.5		New well installed by IT; multilevel well. Inspected August 2001; NPI
C	IR28	IR28MW934F5	Bedrock	451853.685	1461747.7	30.3	9.05	8.80	29.5	30.0	-20.45	-20.95	POLY	1.7	1/19/01	HSA	8.5		New well installed by IT; multilevel well. Inspected August 2001; NPI
C	IR28	IR28MW935F	Bedrock	451845.064	1461760.89	20.0	9.02	8.76	10.0	20.0	-0.98	-10.98	PVC	4	1/24/01	HSA	8.5		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW936F	Bedrock	451862.918	1461769.89	20.0	9.05	8.86	10.0	20.0	-0.95	-10.95	PVC	4	1/24/01	HSA	10		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28MW937F	Bedrock	451859.785	1461757.19	20.5	9.06	8.68	10.0	20.0	-0.94	-10.94	PVC	4	1/26/01	HSA	10		New well installed by IT. Inspected August 2001; NPI
C	IR28	IR28P155AA	A	452211.23	1462444.77	22.0	8.79	8.34	6.0	21.0	2.79	-12.21	PVC	4	6/21/95	ACH	10		Inspected August 2001; NPI
C	IR28	IR28P155AB	A/B	452197.59	1462404.21	21.0	9.65	9.13	6.0	21.0	3.65	-11.35	PVC	4	6/21/95	ACH	10		Inspected August 2001; NPI
C	IR28	IR28P50AA	A	452457.02	1462909.94	18.0	8.82	8.16	5.0	18.0	3.82	-9.18	PVC	4	6/27/95	ACH	10		Could not locate August 2001.
C	IR28	IR28P50AB	A/B	452432.19	1462892.37	21.0	9.00	8.63	5.0	20.0	4.00	-11.00	PVC	4	6/20/95	ACH	10		Inspected August 2001; NPI
C	IR28	IR58MW31A	A	452327.63	1461866.28	15.5	9.47	8.97	5.0	15.5	4.47	-6.03	PVC	4	5/11/94	ACH	10		Inspected March 2000; NPI
C	IR28	IR58MW32B	B	452383.00	1461949.00	25.0	9.19	8.77	9.5	24.5	-0.31	-15.31	PVC	4	3/28/96	ARCH	12		Inspected March 2000; vault replaced November 14, 2000, and repaired January 8, 2001
C	IR28	IR58MW33B	B	452331.00	1461867.00	25.0	9.30	9.06	18.0	25.0	-8.71	-15.71	PVC	4	4/3/96	ARCH	12		Inspected March 2000; vault repaired January 8, 2001
C	IR28	PA28MW50A	A	452433.63	1462922.12	20.0	9.08	8.60	5.0	20.0	4.08	-10.92	PVC	4	2/18/93	ACH	10		Inspected March 2000; NPI
C	IR28	PA28MW51A	A	452324.96	1462521.15	26.5	8.79	8.41	6.0	26.5	2.79	-17.71	PVC	4	2/18/93	ACH	10		Inspected March 2000; NPI
C	IR28	PA28MW52A	A	452391.41	1462471.98	21.5	8.99	8.58	6.0	21.0	2.99	-12.01	PVC	4	2/19/93	ACH	10		Inspected March 2000; well contains product

TABLE 4-1 (Continued)

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
C	IR28	PA28P02A	A	451767.69	1462164.23	21.0	8.28	7.73	6.0	21.0	2.28	-12.72	PVC	4	12/11/92	ACH	10		Inspected August 2001; NPI
C	IR28	PA28P03A	A	452372.25	1462979.92	18.5	8.36	7.71	4.5	18.5	3.86	-10.14	PVC	4	12/9/92	ACH	10		Inspected August 2001; NPI
C	IR28	PA28P04A	A	452323.43	1462274.53	18.5	8.98	8.37	5.0	18.5	3.98	-9.52	PVC	4	12/16/92	ACH	10		Inspected August 2001; NPI
C	IR29	IR29MW48A	A	451611.61	1461535.91	10.0	8.65	8.04	4.5	10.0	4.15	-1.35	PVC	4	5/9/94	ACH	10		Inspected March 2000; NPI
C	IR29	IR29MW56F	Bedrock	451579.82	1461636.64	15.0	8.65	8.27	6.0	15.0	2.65	-6.35	PVC	4	7/19/94	ARCH	10		Inspected March 2000; NPI
C	IR29	IR29MW57A	A	451754.40	1461589.76	11.0	8.40	7.67	5.0	11.0	3.40	-2.60	PVC	4	5/10/94	ACH	10		Inspected March 2000; NPI
C	IR29	IR29MW58F	Bedrock	451768.53	1461587.20	19.0	8.96	8.54	15.0	19.0	-6.04	-10.04	PVC	4	11/10/94	ACH	10		Inspected March 2000; redeveloped by R&M (June/July 2000)
C	IR29	IR29MW59F	Bedrock	451397.07	1461774.92	25.5	8.53	8.21	15.0	25.0	-6.47	-16.47	PVC	4	10/28/94	ACH	10		Inspected March 2000; NPI
C	IR29	IR29MW72F	Bedrock	452015.08	1461313.69	26.5	9.69	9.27	6.0	26.0	3.69	-16.31	PVC	4	7/12/94	ARCH	10		Inspected March 2000; NPI
C	IR29	IR29MW84A	A	451331.00	1461736.00	11.5	8.54	8.09	6.0	11.0	2.54	-2.46	PVC	4	10/19/95	ACH	10		Inspected February 2001; vault replaced July 25, 2001
C	IR29	IR29MW85F	Bedrock	451968.00	1461530.00	22.0	10.19	9.66	6.5	21.5	3.69	-11.31	PVC	4	4/2/96	ARCH	12		Inspected Jan 2001; vault replaced July 26, 2001
C	IR50	IR50MW13F	Bedrock	451706.28	1461287.91	16.5	8.18	7.68	6.0	16.0	2.18	-7.82	PVC	4	8/29/94	ARCH	10		Inspected March 2000; NPI
C	IR50	PA50MW03A	A	451894.37	1462779.63	14.5	7.51	7.03	4.5	14.5	3.01	-6.99	PVC	4	3/8/93	ACH	10		Inspected March 2000; NPI
C	IR50	PA50MW04A	A	451730.49	1461288.61	13.0	8.14	7.56	4.5	13.0	3.64	-4.86	PVC	4	3/9/93	ACH	10		Inspected March 2000; NPI
C	IR57	IR57MW30A	A	451546.00	1460860.00	21.5	8.69	8.02	6.0	21.0	2.69	-12.31	PVC	4	10/31/95	ACH	10		Inspected April 2000; vault replaced August 2, 2001
C	IR58	IR58MW24F	Bedrock	452594.52	1461436.65	23.5	14.18	15.48	13.0	23.5	1.18	-9.32	PVC	4	6/7/94	ACH	10		Inspected March 2000; NPI
C	IR58	IR58MW25F	Bedrock	452406.88	1461694.64	27.5	10.49	9.82	17.0	27.5	-6.51	-17.01	PVC	4	6/6/94	ACH	10		Inspected May 2000; redeveloped by R&M (June/July 2000)
C	IR58	IR58MW26A	A	452434.08	1461881.65	21.5	8.71	8.24	6.0	21.5	2.71	-12.79	PVC	4	5/26/94	HSA	12		Inspected March 2000; vault replaced November 14, 2000
C	IR64	IR64MW05A	A	452600.00	1462163.00	10.5	8.22	7.83	5.0	10.0	3.22	-1.78	PVC	4	9/20/95	HSA	10		Inspected March 2000; NPI
D	IR08	IR08MW37A	A	449774.87	1460446.88	22.0	4.50	4.25	7.0	22.0	-2.50	-17.50	PVC	4	4/27/90	HSA	10		Inspected April 2000; vault replaced 11/16/00; vault repaired February 2, 2001; requires redevelopment before resampling
D	IR08	IR08MW38A	A	449844.08	1460353.82	24.5	7.17	6.91	6.5	24.5	0.67	-17.33	PVC	4	7/3/90	ARCH	10		Inspected April 2000; vault repaired January 22, 2001
D	IR08	IR08MW39A	A	449707.09	1460602.33	36.0	5.44	5.05	6.0	36.0	-0.56	-30.56	PVC	4	7/2/90	ACH	10	b	Decommissioned
D	IR08	IR08MW40A	A	449616.38	1460446.00	28.0	6.05	5.41	8.0	28.0	-1.95	-21.95	PVC	4	5/14/90	HSA	10		Inspected April 2000; NPI
D	IR08	IR08MW41A	A	449622.15	1460311.58	25.5	6.96	6.34	5.5	25.5	1.46	-18.54	PVC	4	5/10/90	HSA	10		Inspected April 2000; vault repaired January 4, 2001
D	IR08	IR08MW42A	A	449753.06	1460483.68	20.5	4.72	4.15	10.5	20.5	-5.78	-15.78	PVC	4	9/10/91	HSA	11	3/15/01	Decommissioned
D	IR08	IR08MW43A	A	450000.03	1460709.59	21.5	8.62	8.82	6.0	21.0	2.62	-12.38	PVC	4	9/15/94	ACH	10	b	Decommissioned
D	IR08	IR08MW44A	A	450028.23	1460125.99	21.5	6.35	5.94	6.0	21.0	0.35	-14.65	PVC	4	9/15/94	ACH	10		Inspected April 2000; vault repaired January 26, 2001
D	IR08	IR08MWW-6	A	449678.77	1460750.86	20.5	5.80	4.88	10.5	20.5	-4.70	-14.70	PVC	2	1/9/87	HSA	8		Inspected April 2000; NPI
D	IR08	IR08P39A	A	449716.59	1460591.81	36.0	5.30	4.91	6.0	36.0	-0.70	-30.70	PVC	2	3/10/92	ACH	7		Inspected August 2001; NPI
D	IR09	IR09MW31A	A	451129.41	1460221.19	12.0	9.01	8.42	7.0	12.0	2.01	-2.99	PVC	4	3/28/90	HSA	10		Located during Phase II sampling. Vault condition poor; repair activities pending.
D	IR09	IR09MW35A	A	450896.82	1460167.05	19.0	9.38	8.71	8.0	19.0	1.38	-9.62	PVC	4	4/10/90	HSA	10		Inspected April 2000; vault repaired January 26, 2001
D	IR09	IR09MW36A	A	450865.77	1460016.40	21.0	9.42	8.87	11.0	21.0	-1.59	-11.59	PVC	4	4/9/90	HSA	10		Inspected April 2000; vault repaired January 29, 2001
D	IR09	IR09MW37A	A	451041.25	1459968.89	14.0	9.63	9.15	7.5	14.0	2.13	-4.37	PVC	4	3/29/90	HSA	10		Inspected April 2000; vault repaired January 29, 2001
D	IR09	IR09MW38A	A	451125.17	1460065.84	12.5	9.41	9.02	7.5	12.5	1.91	-3.09	PVC	4	4/10/90	HSA	10		Inspected February 2001; vault replaced July 30, 2001
D	IR09	IR09MW39A	A	451045.17	1460109.18	23.1	8.86	8.18	13.1	23.1	-4.24	-14.24	PVC	4	9/16/91	HSA	9		Inspected August 2001; vault requires replacement
D	IR09	IR09MW44A	A	450794.91	1460113.91	17.5	9.20	8.78	7.5	17.5	1.70	-8.30	PVC	4	9/23/91	HSA	11		Inspected April 2000; NPI
D	IR09	IR09MW45F	Bedrock	451332.34	1460176.89	17.5	8.88	8.46	7.0	17.0	1.88	-8.12	PVC	4	7/27/94	ARCH	10.25		Inspected April 2000; NPI
D	IR09	IR09MW51F	Bedrock	451311.00	1459991.00	21.5	8.95	8.64	6.0	21.0	2.95	-12.05	PVC	4	2/1/96	ARCH	10		Inspected April 2000; NPI
D	IR09	IR09MW52A	A	450969.00	1459852.00	21.0	9.83	9.59	5.8	20.8	4.08	-10.92	PVC	2	2/6/96	HSA	10		Inspected April 2000; NPI
D	IR09	IR09MW54B	B	451173.52	1460215.56	29.0	9.51	9.26	25.0	29.0	-15.49	-19.49	PVC	4	10/3/00	ARCH	10		New well constructed by IT October 2000. Inspected August 2001; NPI
D	IR09	IR09MW55B	B	450901.16	1460174.42	44.0	9.31	9.07	35.0	44.0	-25.69	-34.69	PVC	4	9/12/00	ARCH	10		New well constructed by IT September 2000. Inspected August 2001; NPI
D	IR09	IR09P040A	A	450857.02	1460365.60	15.8	9.46	9.05	10.8	15.8	-1.34	-6.34	PVC	2	9/12/91	HSA	9		Could not locate August 2001
D	IR09	IR09P041A	A	450970.38	1460346.79	17.0	9.44	8.86	12.0	17.0	-2.56	-7.56	PVC	2	9/11/91	HSA	9		Inspected August 2001; NPI
D	IR09	IR09P042A	A	450824.36	1460212.51	40.0	9.46	8.91	35.0	40.0	-25.54	-30.54	PVC	2	9/12/91	HSA	9		Inspected August 2001; NPI
D	IR09	IR09P043A	A	450825.73	1460218.21	15.1	9.48	8.96	10.1	15.1	-0.62	-5.62	PVC	2	9/16/91	HSA	9		Redeveloped by IT Jan 2001. Inspected August 2001; NPI
D	IR09	IR09P35AA	A	450893.16	1460155.42	25.0	9.41	8.75	5.0	25.0	4.41	-15.59	PVC	2	1/29/92	HSA	8		Inspected August 2001; NPI
D	IR09	IR09P35AB	A	450903.31	1460192.39	25.0	9.37	8.76	5.0	25.0	4.37	-15.63	PVC	2	1/29/92	HSA	8		Inspected August 2001; NPI

TABLE 4-1 (Continued)

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
D	IR09	IR09PPY1	A	451193.63	1460025.14	17.0	9.04	8.78	7.0	17.0	2.04	-7.96	PVC	2	6/15/89	Failing FA-100	8		Vegetation removed from screen at ~ 16.5' bgs, redeveloped by IT January 2001. Inspected August 2001; NPI
D	IR16	PA16MW16A	A	449027.91	1460944.95	20.0	8.88	8.58	5.0	20.0	3.88	-11.12	PVC	4	2/5/91	HSA	11	b	Decommissioned
D	IR16	PA16MW17A	A	448951.05	1460992.25	16.5	8.67	8.45	4.0	16.5	4.67	-7.83	PVC	4	2/5/91	HSA	11		Inspected April 2000; vault repaired February 6, 2001
D	IR16	PA16MW18A	A	449007.88	1461032.00	20.3	8.79	8.36	5.3	20.3	3.49	-11.51	PVC	4	2/6/91	HSA	11		Inspected April 2000; NPI
D	IR17	IR17MW11A	A	449018.79	1461248.45	17.3	8.56	7.85	4.3	17.3	4.26	-8.74	PVC	4	7/17/91	HSA	11		Inspected April 2000; vault repaired January 29, 2001
D	IR17	IR17MW12A	A	448702.95	1461275.71	17.3	8.54	7.72	4.5	17.3	4.04	-8.76	PVC	4	7/15/91	HSA	11		Inspected April 2000; vault repaired January 29, 2001
D	IR17	IR17MW13A	A	448801.65	1461433.94	17.5	7.86	6.98	4.5	17.5	3.36	-9.64	PVC	4	7/16/91	HSA	11		Inspected April 2000; NPI
D	IR17	IR17P12AA	A	448735.67	1461233.50	20.0	8.42	9.59	5.0	20.0	3.42	-11.58	PVC	2	2/7/92	HSA	8		Inspected August 2001; NPI
D	IR17	IR17P12AB	A	448696.18	1461285.57	20.0	8.54	9.82	5.0	20.0	3.54	-11.46	PVC	2	2/7/92	HSA	8		Inspected August 2001; NPI
D	IR22	IR22MW07A	A	450786.73	1461477.20	22.0	8.36	7.82	7.0	22.0	1.36	-13.64	PVC	4	5/12/93	ACH	10		Inspected April 2000; NPI
D	IR22	IR22MW08A	A	450863.92	1461203.01	21.0	9.39	8.77	6.0	21.0	3.39	-11.61	PVC	4	4/27/93	ACH	10		Inspected April 2000; NPI
D	IR22	IR22MW15A	A	450628.06	1461060.80	22.0	8.94	10.82	7.0	22.0	1.94	-13.06	PVC	4	4/29/93	ACH	10		Inspected April 2000; NPI
D	IR22	IR22MW16A	A	450477.73	1461285.16	23.0	8.31	7.86	7.0	22.0	1.31	-13.69	PVC	4	5/3/93	ACH	10		Inspected April 2000; NPI
D	IR22	IR22MW20A	A	450697.66	1461263.17	21.5	8.37	7.84	6.0	21.0	2.37	-12.63	PVC	4	10/6/94	ACH	10		Inspected April 2000; NPI
D	IR22	IR22P15A1	A	450620.88	1461053.50	24.5	8.93	10.75	7.0	24.5	1.93	-15.57	PVC	2	9/29/93	HSA	8		Inspected August 2001; NPI
D	IR22	IR22P15A2	A	450638.28	1461050.55	22.0	9.96	11.00	7.0	22.0	2.96	-12.04	PVC	2	9/29/93	HSA	8		Inspected August 2001; NPI
D	IR33	IR33MW61A	A	451372.52	1460665.32	18.5	9.64	12.26	3.5	18.0	6.14	-8.36	PVC	4	8/1/94	ACH	9.5		Inspected April 2000; NPI
D	IR33	IR33MW62A	A	451365.48	1460383.21	15.5	8.54	8.21	5.0	15.0	3.54	-6.47	PVC	4	8/2/94	ACH	10		Inspected April 2000; NPI
D	IR33	IR33MW63A	A	450286.29	1460464.88	21.5	8.40	7.80	6.0	21.0	2.40	-12.60	PVC	4	10/11/94	ACH	10		Inspected April 2000; NPI
D	IR33	IR33MW64A	A	451393.60	1460584.79	12.0	8.33	9.30	6.0	12.0	2.33	-3.67	PVC	4	10/19/94	ACH	10		Inspected April 2000; NPI
D	IR33	IR33MW65A	A	451292.17	1460515.99	16.5	8.84	8.32	6.0	16.0	2.84	-7.16	PVC	4	10/6/94	ACH	10		Inspected April 2000; NPI
D	IR33	IR33MW66A	A	451286.80	1460642.52	21.5	9.57	8.91	6.0	21.0	3.57	-11.43	PVC	4	10/7/94	ACH	10		Inspected April 2000; NPI
D	IR33	IR33MW116A	A	451038.00	1460314.00	21.5	8.69	8.38	6.0	21.0	2.69	-12.31	PVC	4	7/31/95	HSA	10		Inspected April 2000; NPI
D	IR33	IR33MW120B	B	450461.72	1460272.42	71.0	9.57	9.45	67.0	71.0	-57.43	-61.43	PVC	4	10/9/00	ARCH	10		New well constructed by IT October 2000
D	IR33	IR33MW121B	B	450236.70	1460267.80	73.0	7.57	7.20	69.0	73.0	-61.43	-65.43	PVC	4	10/13/00	ARCH	10		New well constructed by IT October 2000. Inspected August 2001; NPI
D	IR33	PA33MW36A	A	450576.96	1460454.07	21.0	9.66	9.24	6.0	21.0	3.66	-11.34	PVC	4	3/2/93	ACH	10		Inspected August 2001; NPI
D	IR33	PA33MW37A	A	450453.82	1460265.97	21.0	9.58	9.27	6.0	21.0	3.58	-11.42	PVC	4	3/2/93	ACH	10		Inspected April 2000; NPI
D	IR34	IR34MW01A	A	451139.81	1460666.50	16.0	9.02	8.62	5.5	15.5	3.52	-6.48	PVC	4	9/6/94	ACH	10		Inspected April 2000; NPI
D	IR34	IR34MW02A	A	450665.26	1460765.36	21.5	8.57	8.03	6.0	21.0	2.57	-12.43	PVC	4	9/20/94	ACH	10		Inspected April 2000; NPI
D	IR34	IR34MW35A	A	451146.00	1460737.00	21.5	9.12	8.15	6.0	21.0	3.12	-11.88	PVC	4	1/2/96	ACH	10		Inspected August 2001; vault repaired August 01, 2001; requires redevelopment before resampling
D	IR34	IR34MW36A	A	451107.50	1460496.54	18.1	9.55	8.80	9.1	18.1	0.45	-8.55	PVC	4	9/22/00	HSA	12		New well constructed by IT Sep 2000. Inspected August 2001; NPI
D	IR34	IR34MW36B	B	451102.04	1460505.76	33.0	9.48	9.23	24.0	33.0	-14.52	-23.52	PVC	4	9/26/00	ARCH	10		New well constructed by IT Sep 2000. Inspected August 2001; NPI
D	IR34	IR34MW37A	A	450973.94	1460818.33	20.0	9.04	8.78	6.0	20.0	3.04	-10.96	PVC	4	9/22/00	HSA	12		New well constructed by IT Sep 2000. Inspected August 2001; NPI
D	IR34	IR34MW37B	B	450978.74	1460811.48	34.0	8.94	8.60	30.0	34.0	-21.06	-25.06	PVC	4	9/28/00	ARCH	10		New well constructed by IT Sep 2000. Inspected August 2001; NPI
D	IR35	IR35MW01A	A	450837.82	1461016.50	21.0	9.29	8.85	5.5	20.5	3.79	-11.21	PVC	4	9/12/94	ARCH	10		Inspected August 2001; NPI
D	IR35	PA35P01A	A	451005.81	1460889.88	21.0	8.64	8.14	6.0	21.0	2.64	-12.36	PVC	4	12/15/92	ARCH	8.6		Inspected August 2001: NPI
D	IR36	IR36MW16A	A	450481.39	1459903.70	26.5	9.00	8.26	6.0	26.0	3.00	-17.00	PVC	4	9/6/94	ACH	10		Inspected August 2001: NPI
D	IR37	IR37MW01A	A	450931.20	1459697.63	21.5	8.15	7.59	6.0	21.0	2.15	-12.85	PVC	4	9/14/94	ACH	10		Inspected August 2001: NPI
D	IR37	IR37MW26B	B	450935.68	1459690.47	35.0	8.33	8.14	30.0	35.0	-21.67	-26.67	PVC	4	9/22/00	ARCH	10		Inspected August 2001: NPI
D	IR38	IR38MW01A	A	449948.94	1459798.96	34.5	5.14	4.28	14.0	34.0	-8.87	-28.87	PVC	4	9/9/94	ACH	10		Inspected April 2000; NPI
D	IR38	IR38MW02A	A	449711.97	1459636.32	30.5	3.33	2.88	10.0	30.0	-6.67	-26.67	PVC	4	9/12/94	ACH	10		Inspected April 2000; NPI
D	IR38	IR38MW03A	A	449836.01	1459908.07	21.5	4.60	4.00	6.0	21.0	-1.40	-16.40	PVC	4	9/7/94	ACH	10		Inspected April 2000; NPI
D	IR39	PA39MW01A	A	449679.96	1460061.44	26.0	4.98	4.53	6.0	26.0	-1.02	-21.02	PVC	4	2/16/93	ACH	10		Inspected April 2000; NPI
D	IR39	PA39MW02A	A	449507.34	1459823.54	25.0	5.37	6.26	4.5	25.0	0.87	-19.63	PVC	4	2/17/93	ACH	10		Inspected April 2000; NPI
D	IR44	IR44MW08A	A	450228.00	1460271.00	15.5	8.00	7.68	5.0	15.0	3.00	-7.00	PVC	4	9/18/95	HSA	10		Inspected April 2000; vault repaired January 22, 2001
D	IR50	IR50MW14A	A	449236.43	1461109.98	22.0	7.49	6.86	6.3	21.5	1.24	-14.01	PVC	4	5/27/94	HSA	12		Inspected April 2000; vault replaced November 15, 2000
D	IR50	IR50MW15A	A	449294.77	1461148.80	20.8	7.36	6.89	5.3	20.3	2.06	-12.94	PVC	4	6/3/94	HSA	10.25		Inspected February 2001; vault repaired August 1, 2001

TABLE 4-1 (Continued)

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
D	IR50	PA50MW05A	A	449286.04	1461067.57	11.5	6.49	6.07	5.0	11.5	1.49	-5.01	PVC	4	4/14/93	ACH	10		Inspected August 2001; vault repaired August 15, 2001
D	IR50	PA50MW06A	A	450121.63	1460287.66	15.5	8.11	7.64	5.0	15.0	3.11	-6.89	PVC	4	4/13/93	ACH	10		Inspected April 2000; vault replaced November 16, 2000
D	IR50	PA50MW07A	A	450212.10	1461120.11	12.5	9.18	8.71	5.0	12.0	4.18	-2.82	PVC	4	4/15/93	ACH	10		Inspected February 2001; vault replaced August 3, 2001
D	IR50	PA50MW11A	A	451387.46	1460759.71	17.0	8.21	7.66	5.0	17.0	3.21	-8.79	PVC	4	4/15/93	ACH	10		Inspected April 2000; NPI
D	IR50	PA50MW12A	A	450938.32	1460037.10	16.5	9.03	8.62	5.0	16.5	4.03	-7.47	PVC	4	4/16/93	ACH	10		Inspected April 2000; NPI
D	IR55	IR55MW01A	A	449724.63	1460981.89	14.5	5.87	5.14	4.5	14.5	1.37	-8.63	PVC	4	9/16/94	ACH	10		Inspected April 2000; NPI
D	IR55	IR55MW02A	A	449837.45	1461258.09	21.5	7.78	7.24	6.0	21.0	1.78	-13.22	PVC	4	9/21/94	ACH	10		Inspected February 2001; vault replaced July 26, 2001
D	IR55	IR55MW04A	A	449459.46	1461111.22	21.5	5.32	4.80	6.0	21.0	-0.68	-15.68	PVC	4	9/22/94	ACH	10		Inspected April 2000; vault replaced November 14, 2000
D	IR67	IR67MW04A	A	450283.00	1459904.00	21.5	8.77	8.17	6.0	21.0	2.77	-12.23	PVC	4	8/22/95	HSA	10		Inspected April 2000; vault repaired January 26, 2001
D	IR70	IR70MW04A	A	450070.00	1460746.00	21.5	7.60	9.82	6.0	21.0	1.60	-13.40	PVC	4	8/10/95	ARCH	10		Inspected April 2000; NPI
D	IR70	IR70MW07A	A	450042.00	1460969.00	20.5	11.32	10.94	5.0	20.0	6.32	-8.68	PVC	4	9/5/95	HSA	10		Inspected April 2000; NPI
D	IR70	IR70MW11A	A	449845.00	1460936.00	21.5	6.41	9.04	6.0	21.0	0.41	-14.59	PVC	4	8/3/95	ARCH	10		Inspected April 2000; NPI
D	IR70	IR70MW12A	A	449990.00	1461100.00	21.5	8.97	8.47	6.0	21.0	2.97	-12.03	PVC	4	9/18/95	HSA	10		Inspected April 2000; NPI
D	IR71	IR71MW03A	A	450402.00	1460718.00	21.5	8.58	8.31	6.0	21.0	2.58	-12.42	PVC	4	8/17/95	HSA	10		Inspected April 2000; NPI
D	IR71	IR71MW12B	B	450397.77	1460725.29	100.3	8.48	8.23	91.0	100.0	-82.52	-91.52	PVC	4	9/18/00	ARCH	10		New well constructed by IT September 2000. Inspected August 2001; NPI
D	PA32	PA32MW04A	A	449778.34	1461767.39	26.0	7.43	7.05	5.5	25.5	1.93	-18.07	PVC	4	2/24/93	ACH	10		Inspected April 2000; vault repaired February 2, 2001
E	IR01	IR01MW02B	B	452006.87	1457472.91	37.0	19.16	20.61	27.0	37.0	-7.84	-17.84	PVC	4	4/19/91	MRD	10		Inspected April 2000; NPI
E	IR01	IR01MW03A	A	451997.51	1457475.96	27.0	18.96	19.97	12.0	27.0	6.96	-8.05	PVC	4	4/24/91	MRD	10		Inspected April 2000; NPI
E	IR01	IR01MW05A	A	451888.61	1457735.94	26.5	19.66	21.41	9.5	26.5	10.16	-6.84	PVC	4	4/28/92	ACH	10		Inspected April 2000; NPI
E	IR01	IR01MW07A	A	451645.08	1458217.06	22.0	16.90	19.02	5.0	22.0	11.90	-5.10	PVC	4	3/8/90	HSA	12		Inspected April 2000; NPI
E	IR01	IR01MW09B	B	451291.11	1458505.08	42.0	10.35	10.05	32.0	42.0	-21.65	-31.65	PVC	4	1/17/92	ARCH	10		Inspected April 2000; NPI
E	IR01	IR01MW16A	A	451755.55	1457454.71	26.5	--	23.85	--	--	9.02	-5.98	PVC	4	4/29/92	ACH	10		Inspected April 2000; oxygen-deficient condition present April 2001
E	IR01	IR01MW17B	B	451696.82	1457521.49	47.0	--	29.95	--	--	-15.16	-25.16	PVC	4	1/22/92	ARCH	10		Inspected April 2000; NPI
E	IR01	IR01MW18A	A	451487.33	1457687.42	28.0	--	22.94	--	--	8	-10	PVC	4	4/30/92	ACH	10		Inspected April 2000; NPI
E	IR01	IR01MW26B	B	451271.85	1457812.14	51.0	--	23.38	--	--	-24.32	-34.32	PVC	4	4/16/91	MRD	10		Well recently located during Phase II sampling; NPI
E	IR01	IR01MW31A	A	451709.10	1457116.33	24.0	11.58	13.81	6.0	24.0	5.58	-12.42	PVC	4	5/1/92	ACH	10		Inspected April 2000; NPI
E	IR01	IR01MW38A	A	451265.90	1457596.70	20.0	--	17.30	--	--	4.19	-8.81	PVC	4	4/23/91	MRD	10		Inspected April 2000; NPI
E	IR01	IR01MW42A	A	450889.61	1458141.19	25.0	--	14.03	--	--	-5.23	-13.73	PVC	4	10/25/90	HSA	12		Inspected March 2001; internal well ID may need updating
E	IR01	IR01MW43A	A	450750.54	1457799.87	22.5	10.12	12.16	5.0	22.5	5.12	-12.38	PVC	4	3/6/91	HSA	12		Inspected April 2000; NPI
E	IR01	IR01MW44A	A	450427.81	1457854.56	8.0	6.55	9.22	4.0	8.0	2.55	-1.45	PVC	4	3/6/91	HSA	12		Inspected April 2000; NPI
E	IR01	IR01MW47B	B	450733.52	1457831.85	45.0	10.24	12.31	35.0	45.0	-24.76	-34.76	PVC	4	1/15/92	ARCH	10		Inspected April 2000; NPI
E	IR01	IR01MW48A	A	451235.62	1457143.24	18.0	9.12	10.96	5.0	18.0	4.12	-8.88	PVC	4	10/24/90	HSA	12		Inspected April 2000; NPI
E	IR01	IR01MW53B	B	451238.55	1457131.37	44.0	8.78	10.01	34.0	44.0	-25.22	-35.22	PVC	4	4/11/91	MRD	10		Inspected April 2000; NPI
E	IR01	IR01MW58A	A	450892.94	1456447.14	16.5	7.10	9.19	4.0	16.5	3.10	-9.41	PVC	4	3/7/91	HSA	12		Inspected April 2000; NPI
E	IR01	IR01MW62A	A	450607.92	1456381.18	13.0	6.43	7.91	3.0	13.0	3.43	-6.57	PVC	4	1/7/92	HSA	12		Inspected April 2000; NPI
E	IR01	IR01MW63A	A	450630.23	1456253.77	18.0	6.38	7.88	4.0	18.0	2.38	-11.62	PVC	4	12/18/91	HSA	12		Inspected April 2000; NPI
E	IR01	IR01MW366A	A	451037.00	1458223.00	15.5	--	16.74	--	--	10.14	0.14	PVC	4	10/20/95	ACH	10		Inspected April 2000; NPI
E	IR01	IR01MW367A	A	451289.00	1458347.00	15.5	10.21	12.12	5.0	15.0	5.21	-4.79	PVC	4	10/24/95	ACH	10		Inspected April 2000; NPI
E	IR01	IR01MW400A	A	450719.00	1456254.00	20.5	9.20	11.58	5.0	20.0	4.20	-10.80	PVC	4	6/20/96	HSA	10		Inspected April 2000; NPI
E	IR01	IR01MW401A	A	451006.00	1456459.00	20.5	14.30	13.87	5.0	20.0	9.30	-5.70	PVC	4	6/20/96	HSA	10		Inspected April 2000; NPI
E	IR01	IR01MW402A	A	451251.00	1456651.00	21.0	13.34	12.51	5.5	20.5	7.84	-7.16	PVC	4	6/25/96	HSA	10		Inspected April 2001; needs replacement lock
E	IR01	IR01MW403A	A	451822.00	1457071.00	21.5	13.37	13.00	6.0	21.0	7.37	-7.63	PVC	4	6/21/96	HSA	10		Inspected April 2000; NPI
E	IR01	IR01MWI-2	A	451135.09	1458317.62	20.5	12.35	13.22	5.5	20.5	6.85	-8.15	SS	2	9/11/86	HSA	8		Inspected April 2000; NPI
E	IR01	IR01MWI-3	A	450902.28	1457612.06	17.0	12.56	13.80	4.0	17.0	8.56	-4.44	SS	2	9/11/86	HSA	8		Inspected April 2000; NPI
E	IR01	IR01MWI-5	A	451212.67	1457828.17	20.0	--	15.44	--	--	10.91	-4.09	SS	2	9/29/86	HSA	8		Inspected April 2000; NPI
E	IR01	IR01MWI-6	A	451202.46	1456676.72	11.5	8.89	9.55	4.0	11.5	4.89	-2.61	SS	2	9/16/86	HSA	8		Inspected August 2001; NPI
E	IR01	IR01MWI-7	A	451007.37	1456811.65	13.0	5.79	5.81	3.0	13.0	2.79	-7.21	SS	2	9/16/86	HSA	8		Inspected April 2001; NPI
E	IR01	IR01MWI-8	A	450486.93	1456477.47	12.5	4.12	6.64	2.0	12.0	2.12	-7.88	SS	2	9/16/86	HSA	8		Inspected April 2000; NPI

TABLE 4-1 (Continued)

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
E	IR01	IR01MWI-9	A	451130.81	1456783.26	13.0	7.34	8.00	3.0	13.0	4.34	-5.66	SS	2	9/30/86	HSA	8		Inspected April 2000; NPI
E	IR01	IR01P03A	A	451982.82	1457473.29	27.0	19.43	20.13	7.0	27.0	12.43	-7.57	PVC	2	3/19/92	ARCH	10		Inspected August 2001; NPI
E	IR01	IR01P03AA	A	451995.00	1457488.00	27.5	21.49	20.98	12.0	27.0	9.49	-5.51	PVC	2	10/23/95	ACH	10		Inspected August 2001; NPI
E	IR01	IR01P03AB	A/B	451997.00	1457455.00	27.5	20.47	19.87	12.0	27.0	8.47	-6.53	PVC	2	10/24/95	ACH	10		Inspected August 2001; NPI
E	IR01	IR01P18AB	A/B	451476.00	1457708.00	15.0	19.31	18.91	9.5	14.5	9.81	4.81	PVC	2	1/4/96	ACH	10		Inspected August 2001; NPI
E	IR02	IR02MW87A	A	450403.14	1458255.65	14.5	8.86	8.48	4.5	14.5	4.36	-5.64	PVC	4	3/5/91	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW89A	A	450181.69	1458612.51	21.0	8.58	10.08	6.0	21.0	2.58	-12.42	PVC	4	1/2/92	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW93A	A	449821.52	1459022.89	19.0	7.64	7.25	4.0	19.0	3.64	-11.36	PVC	4	1/12/91	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW97A	A	449365.27	1459533.52	22.0	6.64	8.95	5.0	22.0	1.64	-15.36	PVC	4	3/11/91	HSA	12		Inspected April 2000; redevelopment pending
E	IR02	IR02MW101A1	A	449503.94	1458996.46	17.0	9.23	11.23	7.0	17.0	2.23	-7.77	PVC	4	10/23/90	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW101A2	A	449504.48	1458992.08	34.0	9.24	11.22	27.0	34.0	-17.76	-24.76	PVC	4	10/22/90	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW114A1	A	449776.09	1458510.72	10.0	11.60	13.63	5.0	10.0	6.60	1.60	PVC	4	10/25/90	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW114A2	A	449779.28	1458513.07	25.0	11.55	12.43	13.0	25.0	-1.45	-13.45	PVC	4	10/23/90	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW114A3	A	449774.97	1458515.29	49.0	11.49	13.29	42.0	49.0	-30.51	-37.51	PVC	4	10/24/90	HSA	12		Inspected March 2001; NPI
E	IR02	IR02MW126A	A	450042.18	1457954.82	14.0	10.15	11.36	5.0	14.0	5.15	-3.85	PVC	4	10/26/90	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW127B	B	449934.87	1458163.41	64.0	12.58	14.59	54.0	64.0	-41.42	-51.42	PVC	4	1/14/92	ARCH	10		Inspected April 2000; NPI
E	IR02	IR02MW141A	A	449885.53	1458090.88	16.0	13.54	15.49	6.0	16.0	7.54	-2.46	PVC	4	5/4/92	ACH	10		Inspected April 2000; NPI
E	IR02	IR02MW146A	A	449080.17	1459500.16	18.0	9.43	11.34	6.0	18.0	3.43	-8.57	PVC	4	1/7/92	ARCH	10		Well contains product; not sampled in Aprilil 2001
E	IR02	IR02MW147A	A	449299.98	1458893.50	9.0	7.21	8.36	4.0	9.0	3.21	-1.79	PVC	4	10/30/90	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW149A	A	449335.31	1458701.83	19.5	6.17	8.72	4.5	19.5	1.67	-13.33	PVC	4	3/13/91	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW173A	A	448899.53	1459809.80	19.0	7.82	9.51	6.0	19.0	1.82	-11.18	PVC	4	1/9/92	ARCH	10		Well contains thick product; not sampled in Aprilil 2001
E	IR02	IR02MW175A	A	448340.24	1460641.30	31.0	7.80	7.74	9.0	31.0	-1.20	-23.20	PVC	4	10/17/90	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW179A	A	448306.99	1461054.61	18.0	8.37	9.82	4.5	18.0	3.87	-9.63	PVC	4	10/15/90	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW183A	A	448523.61	1461083.62	34.0	8.73	10.40	4.0	34.0	4.73	-25.27	PVC	4	10/31/90	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW196A	A	448735.65	1460492.35	11.3	8.54	8.05	4.3	11.3	4.24	-2.76	PVC	4	3/7/91	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW206A1	A	448517.20	1460467.97	7.5	5.93	7.43	2.5	7.5	3.43	-1.58	PVC	4	10/18/90	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW206A2	A	448513.75	1460471.23	20.0	5.82	7.41	10.0	20.0	-4.18	-14.18	PVC	4	10/17/90	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW209A	A	448628.02	1460319.72	19.0	5.28	6.34	9.0	19.0	-3.72	-13.72	PVC	4	10/18/90	HSA	12		Inspected April 2000; NPI
E	IR02	IR02MW210B	B	448874.22	1460154.48	30.0	7.19	9.17	22.0	30.0	-14.81	-22.81	PVC	4	1/28/92	ARCH	10		Inspected April 2000; NPI
E	IR02	IR02MW298A	A	449618.76	1458588.99	21.0	9.79	11.80	6.0	21.0	3.79	-11.21	PVC	4	6/10/92	ACH	10		Inspected April 2000; NPI
E	IR02	IR02MW299A	A	448950.23	1460109.04	21.0	8.72	10.56	6.0	21.0	2.72	-12.28	PVC	4	6/3/92	ACH	10		Inspected April 2000; NPI
E	IR02	IR02MW300A	A	448176.80	1460764.39	22.8	7.15	9.00	7.8	22.8	-0.65	-15.65	PVC	4	6/2/92	ACH	10		Inspected March 2001; needs replacement lock
E	IR02	IR02MW372A	A	449944.00	1458166.00	15.5	12.22	14.21	5.0	15.0	7.22	-2.78	PVC	4	10/31/95	ACH	10		Inspected April 2000; NPI
E	IR02	IR02MW373A	A	450174.00	1458019.00	10.5	11.84	11.34	5.0	10.0	6.84	1.84	PVC	4	10/31/95	ACH	10		Inspected April 2000; NPI
E	IR02	IR02MWB-1	A	449248.10	1459161.49	19.5	7.34	8.47	4.0	19.0	3.34	-11.66	SS	2	8/13/86	HSA	8		Inspected March 2001; needs replacement lock
E	IR02	IR02MWB-2	A	449407.48	1458301.67	19.0	11.19	11.88	4.0	19.0	7.19	-7.81	SS	2	8/15/86	HSA	8		Inspected March 2001; internal well ID may need updating
E	IR02	IR02MWB-3	A	449798.42	1458003.26	19.0	12.13	12.95	4.0	19.0	8.13	-6.87	SS	2	8/19/86	HSA	8		Inspected March 2001; needs replacement lock
E	IR02	IR02MWB-5	A	448787.96	1460115.24	17.0	4.78	4.74	3.0	17.0	1.78	-12.22	SS	2	8/20/86	HSA	8		Inspected April 2000; NPI
E	IR02	IR02MWC5-W	A	449728.34	1458911.99	15.0	8.05	7.49	5.0	15.0	3.05	-6.95	PVC	2	5/14/87	HSA	--		Inspected April 2000; NPI
E	IR02	IR02P126AA	A	450059.21	1457959.52	15.0	9.81	10.58	5.0	15.0	4.81	-5.19	PVC	2	2/3/92	HSA	8		Inspected August 2001; NPI
E	IR02	IR02P126AB	A/B	450019.95	1457965.47	15.0	10.05	11.00	5.0	15.0	5.05	-4.95	PVC	2	3/17/92	ACH	10		Inspected August 2001; NPI
E	IR02	IR02P93AA	A	449832.59	1459023.68	20.0	7.81	6.93	5.0	20.0	2.81	-12.19	PVC	2	2/3/92	HSA	8		Inspected August 2001; NPI
E	IR02	IR02P93AB	A/B	449800.21	1459054.68	19.0	7.63	7.11	4.0	19.0	3.63	-11.37	PVC	2	2/6/92	HSA	8		Inspected August 2001; NPI
E	IR02	IR02P97AA	A	449377.03	1459534.06	23.0	5.98	7.09	5.0	23.0	0.98	-17.02	PVC	2	2/4/92	HSA	8		Inspected August 2001; NPI
E	IR02	IR02P97AB	A/B	449351.40	1459521.08	25.0	6.94	7.54	5.0	25.0	1.94	-18.06	PVC	2	3/16/92	ARCH	--		Inspected April 2000; NPI; borehole diameter in question
E	IR03	IR03MW218A1	A	448916.93	1459580.85	10.0	10.05	11.92	4.0	10.0	6.05	0.05	PVC	4	10/30/90	HSA	12		Well contains product; not sampled in Aprilil 2001
E	IR03	IR03MW218A2	A	448918.29	1459567.49	17.5	10.35	12.26	12.5	17.5	-2.15	-7.15	PVC	4	10/31/90	HSA	12		Inspected April 2000; NPI
E	IR03	IR03MW218A3	A	448908.77	1459574.37	30.0	10.07	12.00	20.0	30.0	-9.93	-19.93	PVC	4	10/30/90	HSA	12		Inspected April 2000; NPI
E	IR03	IR03MW224A	A	449089.45	1459700.21	12.5	9.14	10.92	4.5	12.5	4.64	-3.36	PVC	4	1/6/92	HSA	8		Inspected April 2000; NPI

TABLE 4-1 (Continued)

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
E	IR03	IR03MW225A	A	448974.12	1459526.71	19.0	--	12.27	--	--	3.83	-11.17	PVC	4	12/19/91	HSA	12		Well contains product; not sampled in Aprilil 2001
E	IR03	IR03MW226A	A	448893.20	1459608.51	19.0	--	11.81	--	--	3.61	-11.39	PVC	4	12/19/92	HSA	8		Well contains product; not sampled in Aprilil 2001
E	IR03	IR03MW228B	B	448926.20	1459580.66	68.0	10.27	12.12	58.0	68.0	-47.73	-57.73	PVC	4	4/8/91	MRD	10		Well contains product; not sampled in Aprilil 2001
E	IR03	IR03MW342A	A	448886.81	1459905.31	14.5	7.03	8.48	5.0	14.5	2.03	-7.47	PVC	4	6/30/92	ACH	10		Inspected April 2000; NPI
E	IR03	IR03MW369A	A	448796.70	1459789.60	20.0	--	10.01	--	--	4.90	-10.10	PVC	4	10/24/95	ACH	10		Well contains product; not sampled in Aprilil 2001
E	IR03	IR03MW370A	A	448876.00	1459569.00	21.5	--	11.19	--	--	5.86	-9.14	PVC	4	10/25/95	ACH	10		Well contains product; not sampled in Aprilil 2001
E	IR03	IR03MW371A	A	448955.00	1459503.00	21.5	9.87	12.48	6.0	21.0	3.87	-11.13	PVC	4	10/26/95	ACH	10		Well contains product; not sampled in Aprilil 2001
E	IR03	IR03MWO-1	A	449001.74	1459633.43	17.5	--	11.92	--	--	4.41	-10.59	SS	2	8/21/86	HSA	8		Well contains product; not sampled in Aprilil 2001
E	IR03	IR03MWO-2	A	448876.38	1459600.68	20.5	--	11.55	--	--	4.58	-11.92	SS	2	8/22/86	HSA	8		Well contains product; not sampled in Aprilil 2001
E	IR03	IR03MWO-3	A	448975.07	1459514.31	19.0	--	9.22	--	--	4.18	-10.82	SS	2	8/25/86	HSA	8		Well contains product; not sampled in Aprilil 2001
E	IR04	IR04MW09A	A	451276.61	1458684.86	20.0	9.88	9.34	5.0	20.0	4.88	-10.12	PVC	4	11/14/90	HSA	12		Inspected April 2000; NPI
E	IR04	IR04MW13A	A	450972.31	1458394.71	20.0	10.45	12.55	5.0	20.0	5.45	-9.55	PVC	4	10/23/91	HSA	12		Inspected April 2000; NPI
E	IR04	IR04MW31A	A	450800.16	1458293.32	26.0	10.02	12.53	11.0	26.0	-0.98	-15.98	PVC	4	11/15/90	HSA	12		Inspected March 2001; needs replacement lock
E	IR04	IR04MW35A	A	451129.72	1458515.33	27.0	9.38	11.11	7.0	27.0	2.38	-17.62	PVC	4	11/26/90	HSA	12		Inspected April 2000; NPI
E	IR04	IR04MW36A	A	451298.96	1458528.10	26.0	10.36	9.84	6.0	26.0	4.36	-15.64	PVC	4	11/19/90	HSA	12		Inspected April 2000; NPI
E	IR04	IR04MW37A	A	451395.22	1458812.73	22.5	10.25	9.54	7.5	22.5	2.75	-12.25	PVC	4	11/20/90	HSA	12		Inspected April 2000; NPI
E	IR04	IR04MW38A	A	451383.46	1458997.82	21.0	10.41	9.76	6.0	21.0	4.41	-10.59	PVC	4	11/29/90	HSA	12		Inspected August 2001; NPI
E	IR04	IR04MW39A	A	451270.47	1458905.37	25.0	8.82	7.86	5.0	25.0	3.82	-16.18	PVC	4	11/19/90	HSA	12		Inspected April 2000; NPI
E	IR04	IR04MW40A	A	451189.01	1458629.78	27.0	7.98	7.16	5.0	27.0	2.98	-19.02	PVC	4	11/28/90	HSA	12		Inspected April 2000; NPI
E	IR04	IR04P31AA	A	450809.55	1458286.47	19.0	10.99	11.89	9.0	19.0	1.99	-8.01	PVC	2	1/30/92	HSA	8		Inspected August 2001; NPI
E	IR04	IR04P31AB	A/B	450771.13	1458315.48	30.0	10.96	12.14	10.0	30.0	0.96	-19.04	PVC	2	1/30/92	HSA	8		Inspected August 2001; NPI
E	IR04	IR04P38A	A	451390.01	1459020.79	23.0	10.40	9.81	8.0	23.0	2.40	-12.60	PVC	2	1/30/92	HSA	8		Inspected April 2000; NPI
E	IR05	IR05MW73A	A	450550.36	1459079.14	10.5	6.97	6.59	5.5	10.5	1.47	-3.53	PVC	4	11/29/90	HSA	12		Inspected April 2000; NPI
E	IR05	IR05MW74A	A	450522.95	1458965.76	23.0	7.62	7.40	6.0	23.0	1.62	-15.38	PVC	4	11/28/90	HSA	12		Well contains product; not sampled in April 2001
E	IR05	IR05MW76A	A	450772.44	1458809.50	14.0	5.89	4.97	5.0	14.0	0.89	-8.11	PVC	4	11/20/90	HSA	12		Inspected August 2001; NPI
E	IR05	IR05MW77A	A	450760.23	1459014.65	32.8	9.02	10.43	7.0	32.8	2.02	-23.78	PVC	4	11/26/90	HSA	12		Inspected April 2000; NPI
E	IR05	IR05MW82A	A	450589.49	1458785.02	22.0	10.63	12.00	7.0	22.0	3.63	-11.37	PVC	4	11/5/91	HSA	12		Well contains product; not sampled in April 2001
E	IR05	IR05MW85A	A	450738.99	1459148.72	21.0	7.95	9.80	6.0	21.0	1.95	-13.05	PVC	4	6/4/92	ACH	10		Inspected April 2000; NPI
E	IR05	IR05P77AA	A	450770.83	1459012.66	35.0	9.03	10.04	8.0	35.0	1.03	-25.97	PVC	2	2/3/92	HSA	8		Inspected August 2001; NPI
E	IR05	IR05P77AB	A/B	450740.50	1459022.42	35.0	8.94	9.62	5.0	35.0	3.94	-26.06	PVC	2	3/11/92	ARCH	8		Inspected August 2001; NPI
E	IR11	IR11MW25A	A	448959.29	1460519.68	10.0	10.51	11.40	4.0	10.0	6.51	0.51	PVC	4	2/6/89	HSA	11		Inspected April 2000; NPI
E	IR11	IR11MW26A	A	448816.70	1460536.86	9.0	8.60	9.33	5.0	9.0	3.60	-0.40	PVC	4	1/3/89	HSA	11		Inspected April 2000; NPI
E	IR11	IR11MW27A	A	448899.06	1460394.84	10.0	8.86	9.84	5.0	10.0	3.86	-1.14	PVC	4	1/3/89	HSA	11		Inspected April 2000; NPI
E	IR12	IR12MW11A	A	450553.71	1458252.05	17.0	9.44	11.68	4.0	17.0	5.44	-7.56	PVC	4	8/1/91	HSA	11		Inspected April 2000; NPI
E	IR12	IR12MW12A	A	450391.33	1458364.05	17.0	9.08	8.40	4.0	17.0	5.08	-7.92	PVC	4	7/30/91	HSA	11		Requires redevelopment before resampling
E	IR12	IR12MW13A	A	450641.99	1458525.20	19.5	10.20	12.52	4.5	19.5	5.70	-9.30	PVC	4	8/2/91	HSA	11		Inspected April 2000; NPI
E	IR12	IR12MW14A	A	450885.25	1458524.47	20.0	9.18	10.46	5.0	20.0	4.18	-10.82	PVC	4	6/24/91	HSA	11		Inspected April 2000; NPI
E	IR12	IR12MW15A	A	451094.82	1458904.36	20.0	8.11	7.28	5.0	20.0	3.11	-11.89	PVC	4	6/19/91	HSA	11		Inspected April 2000; NPI
E	IR12	IR12MW16A	A	451151.21	1459088.89	16.0	9.27	8.57	6.0	16.0	3.27	-6.73	PVC	4	6/25/91	HSA	11		Well contains product; not sampled in Aprilil 2001
E	IR12	IR12MW17A	A	450592.37	1458435.38	15.0	10.85	12.46	5.0	15.0	5.85	-4.15	PVC	4	8/11/92	ARCH	8		Inspected March 2001; needs replacement well plug
E	IR12	IR12MW18A	A	450587.34	1458515.98	20.0	10.49	12.37	10.0	20.0	0.49	-9.51	PVC	4	8/18/92	ARCH	8		Inspected April 2000; NPI
E	IR12	IR12MW19A	A	450751.51	1458402.17	21.0	10.92	13.02	6.0	21.0	4.92	-10.08	PVC	4	8/13/92	ARCH	8		Inspected April 2000. Aboveground stovepipe unanchored; removable by hand; well head broken off
E	IR12	IR12MW20A	A	450478.54	1458568.79	21.0	10.24	12.27	6.0	21.0	4.24	-10.76	PVC	4	8/13/92	ARCH	8		Inspected April 2000; NPI
E	IR12	IR12MW21A	A	450988.49	1458773.04	20.0	8.20	10.42	5.0	20.0	3.20	-11.80	PVC	4	8/17/92	ARCH	8		Well contains product; not sampled in Aprilil 2001
E	IR12	IR12P12AA	A	450361.58	1458441.15	19.0	8.86	9.81	4.0	19.0	4.86	-10.14	PVC	2	2/4/92	HSA	8		Inspected August 2001; NPI
E	IR12	IR12P12AB	A/B	450395.14	1458353.14	19.0	9.09	10.09	4.0	19.0	5.09	-9.91	PVC	2	2/5/92	HSA	8		Inspected August 2001; NPI
E	IR12	IR12P14AA	A	450893.73	1458515.01	24.0	9.72	10.68	4.0	24.0	5.72	-14.28	PVC	2	2/6/92	HSA	8		Inspected August 2001; NPI
E	IR12	IR12P14AB	A/B	450858.82	1458552.96	25.0	9.14	10.43	5.0	25.0	4.14	-15.86	PVC	2	2/6/92	HSA	8		Inspected August 2001; NPI

TABLE 4-1 (Continued)

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
E	IR13	IR13MW10A	A	449739.48	1459544.26	18.0	4.44	3.56	4.0	18.0	0.44	-13.56	PVC	4	7/1/91	HSA	11		Well recently located, well condition assessment pending
E	IR13	IR13MW11A	A	449614.30	1459413.09	9.5	5.46	4.84	4.5	9.5	0.96	-4.04	PVC	4	7/2/91	HSA	11		Inspected April 2000; NPI
E	IR13	IR13MW12A	A	449527.03	1459518.04	18.0	4.59	4.12	5.0	18.0	-0.42	-13.42	PVC	4	7/2/91	HSA	11		Inspected April 2000; NPI
E	IR13	IR13MWB5A-W	A	449886.42	1459369.84	15.0	6.28	5.93	3.0	13.0	3.28	-6.72	--	2	5/19/87	HSA	8		Inspected April 2000; vault repaired February 5, 2001
E	IR13	IR13P12AA	A	449514.66	1459505.16	18.0	4.73	4.49	8.0	18.0	-3.27	-13.27	PVC	2	3/12/92	ARCH	8		Inspected August 2001; NPI
E	IR13	IR13P12AB	A/B	449534.13	1459552.28	20.0	4.69	4.53	5.0	20.0	-0.31	-15.31	PVC	2	3/13/92	ARCH	8		Inspected August 2001; NPI
E	IR14	IR14MW09A	A	449144.60	1460064.43	13.0	8.21	9.93	5.0	13.0	3.21	-4.79	PVC	4	11/22/91	ARCH	11		Inspected March 2001; internal well ID may need updating
E	IR14	IR14MW10A	A	449298.60	1459987.15	14.8	7.14	8.89	4.8	14.8	2.34	-7.66	PVC	4	7/26/91	HSA	9		Inspected April 2000; NPI
E	IR14	IR14MW12A	A	449397.63	1460394.77	16.5	6.62	8.52	5.0	16.5	1.62	-9.88	PVC	4	11/11/91	ARCH	10		Inspected April 2000; NPI
E	IR14	IR14MW13A	A	449107.96	1460257.30	20.0	7.69	9.75	5.0	20.0	2.69	-12.31	PVC	4	8/10/92	ARCH	8		Well contains product; not sampled in April 2001
E	IR15	IR15MW06A	A	448967.51	1460317.17	19.0	9.12	11.11	6.0	19.0	3.12	-9.88	PVC	4	11/12/91	ARCH	10		Inspected April 2000; NPI
E	IR15	IR15MW07A	A	449139.09	1460712.87	18.0	9.59	11.18	5.0	18.0	4.59	-8.42	PVC	4	11/13/91	ARCH	10		Inspected April 2000; NPI
E	IR15	IR15MW08A	A	449041.19	1460343.13	20.0	9.71	11.70	5.0	20.0	4.71	-10.29	PVC	4	8/6/92	ARCH	8		Inspected April 2000; NPI
E	IR15	IR15MW09F	Bedrock	449022.87	1460582.98	28.0	9.64	11.48	18.0	28.0	-8.36	-18.36	PVC	4	7/22/92	MRD	8		Inspected April 2000; NPI
E	IR15	IR15MW10F	Bedrock	448809.05	1460586.88	28.0	8.98	10.98	18.0	28.0	-9.02	-19.02	PVC	4	7/28/92	MRD	10		Inspected April 2000; NPI
E	IR15	IR15P08AA	A	449048.00	1460353.00	20.5	12.18	11.65	5.0	20.0	7.18	-7.82	PVC	2	10/26/95	ACH	10		Inspected August 2001; NPI
E	IR15	IR15P08AB	A/B	449061.00	1460333.00	20.5	12.01	11.41	5.0	20.0	7.01	-7.99	PVC	2	10/30/95	ACH	10		Inspected August 2001; NPI
E	IR15	IR15P08B	B	449037.00	1460346.00	52.5	11.70	11.11	42.0	52.0	-30.30	-40.30	PVC	2	10/27/95	ACH	10		Inspected August 2001; NPI
E	IR36	IR36MW09A	A	450486.94	1459414.00	21.0	5.57	5.00	5.5	20.5	0.07	-14.93	PVC	4	6/22/94	ACH	10		Inspected April 2000; vault replaced November 15, 2000
E	IR36	IR36MW11A	A	450184.64	1458989.17	21.5	9.00	8.55	6.0	21.0	3.00	-12.00	PVC	4	8/30/94	ARCH	10		Inspected April 2000; NPI
E	IR36	IR36MW12A	A	450044.49	1459108.25	21.5	7.95	7.18	6.0	21.0	1.95	-13.05	PVC	4	9/1/94	ARCH	10		Inspected April 2000; NPI
E	IR36	IR36MW13A	A	450175.58	1459352.74	11.5	6.76	8.96	6.0	11.0	0.76	-4.24	PVC	4	10/10/94	ACH	10		Inspected April 2000; NPI
E	IR36	IR36MW14A	A	450187.95	1459464.23	16.5	6.08	5.52	6.0	16.0	0.08	-9.92	PVC	4	10/19/94	ACH	10		Inspected April 2000; vault repaired January 26, 2001
E	IR36	IR36MW15A	A	450721.17	1459321.00	21.5	7.58	7.04	6.0	21.0	1.58	-13.42	PVC	4	9/1/94	ARCH	10		Inspected April 2000; NPI
E	IR36	IR36MW17A	A	450762.29	1459538.12	21.5	8.85	8.36	6.0	21.0	2.85	-12.15	PVC	4	10/10/94	ACH	10		Inspected April 2000; NPI
E	IR36	IR36MW120B	B	450679.00	1459376.00	73.5	7.81	7.05	58.0	73.0	-50.19	-65.19	PVC	4	12/22/95	ACH	10		Inspected April 2000; NPI
E	IR36	IR36MW121A	A	450681.00	1459370.00	30.5	7.56	6.96	15.0	30.0	-7.44	-22.44	PVC	4	12/19/95	ACH	10		Inspected April 2000; NPI
E	IR36	IR36MW122A	A	450610.00	1459716.00	33.0	8.22	7.64	17.5	32.5	-9.28	-24.28	PVC	4	12/18/95	ACH	10		Inspected April 2000; vault repaired February 2, 2001
E	IR36	IR36MW123B	B	450617.00	1459719.00	65.5	8.22	7.55	50.0	65.0	-41.78	-56.78	PVC	4	12/27/95	ACH	10		Inspected April 2000; NPI
E	IR36	IR36MW125A	A	450539.00	1459423.00	10.0	7.24	6.59	4.5	9.5	2.74	-2.26	PVC	4	12/13/95	ACH	10		Inspected April 2000; vault repaired February 2, 2001
E	IR36	IR36MW126A	A	450483.00	1459441.00	9.5	5.82	5.16	4.0	9.0	1.82	-3.18	PVC	4	12/15/95	ACH	10		Inspected April 2000; vault replaced November 16, 2000
E	IR36	IR36MW127A	A	450538.00	1459376.00	26.5	7.04	6.45	6.0	26.0	1.04	-18.96	PVC	4	12/13/95	ACH	10		Inspected April 2000; NPI
E	IR36	IR36MW128A	A	450362.00	1459784.00	21.5	8.42	8.01	6.0	21.0	2.42	-12.58	PVC	4	12/13/95	ACH	10		Inspected April 2000; vault repaired January 26, 2001
E	IR36	IR36MW129B	B	450362.00	1459778.00	70.0	8.39	7.80	54.5	69.5	-46.11	-61.11	PVC	4	12/27/95	ACH	10		Inspected April 2000; NPI
E	IR36	IR36MW135A	A	450032.00	1458949.00	26.5	8.37	7.85	6.0	26.0	2.37	-17.63	PVC	4	12/15/95	ACH	10		Inspected April 2000; NPI
E	IR36	IR36MW137A	A	450321.00	1459313.00	6.0	8.70	7.76	4.0	5.5	4.70	3.20	PVC	4	12/15/95	ACH	10		Inspected April 2000; vault replaced November 15, 2000
E	IR36	IR36MW139A	A	449974.00	1459192.00	20.0	7.78	7.10	4.5	19.5	3.28	-11.72	PVC	4	1/8/96	ACH	10		Inspected April 2000; could not access, underneath large dumpster
E	IR36	PA36MW01A	A	451045.21	1459275.38	21.5	8.17	7.64	6.0	21.5	2.17	-13.33	PVC	4	2/3/93	ACH	10		Inspected April 2000; NPI
E	IR36	PA36MW02A	A	451040.15	1459443.45	21.5	8.50	8.02	6.0	21.5	2.50	-13.00	PVC	4	2/3/93	ACH	10		Inspected April 2000; NPI
E	IR36	PA36MW03A	A	450770.64	1459177.56	16.0	7.76	9.26	6.0	16.0	1.76	-8.24	PVC	4	2/10/93	ACH	10		Well contains product; not sampled in April 2001
E	IR36	PA36MW04A	A	450362.74	1459550.85	21.0	7.86	7.33	5.5	21.0	2.36	-13.14	PVC	4	2/4/93	ACH	10		Inspected April 2000; NPI
E	IR36	PA36MW05A	A	450149.11	1459672.93	25.5	7.92	7.40	5.0	25.0	2.92	-17.08	PVC	4	2/4/93	ACH	10	b	Decommissioned
E	IR36	PA36MW06A	A	450227.84	1459140.98	26.0	9.55	8.94	6.0	26.0	3.55	-16.45	PVC	4	2/10/93	ACH	10		Inspected August 2001; NPI
E	IR36	PA36MW07A	A	450454.59	1459330.48	20.0	7.37	6.80	5.0	20.0	2.37	-12.63	PVC	4	2/8/93	ACH	10		Inspected March 2001; casing may require repair
E	IR36	PA36MW08A	A	450119.87	1459220.35	21.0	8.13	7.65	6.0	21.0	2.13	-12.87	PVC	4	2/11/93	ACH	10		Inspected March 2001; may need replacement monument cover
E	IR36	PA36P04AA	A	450367.00	1459560.00	21.0	8.17	8.03	5.5	20.5	2.67	-12.33	PVC	2	8/10/95	HSA	8		Inspected August 2001; NPI
E	IR36	PA36P04AB	A/B	450383.00	1459555.00	19.5	8.59	8.47	4.0	19.0	4.59	-10.41	PVC	2	8/10/95	HSA	8		Inspected August 2001; NPI
E	IR39	IR39MW21A	A	449855.96	1459475.49	13.0	5.87	7.92	6.0	13.0	-0.13	-7.13	PVC	4	5/20/94	ACH	10		Inspected April 2000; NPI
E	IR39	IR39MW22A	A	449828.04	1459199.84	20.5	6.60	6.34	5.4	20.4	1.20	-13.80	PVC	4	8/29/94	ACH	9		Inspected April 2000; NPI; borehole diameter in question

TABLE 4-1 (Continued)

BASEWIDE WELL CONSTRUCTION INFORMATION AND CURRENT CONDITIONS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Parcel	IR Site	Well Identification Number	Water-Bearing Zone[a]	Northing	Easting	Constructed Well Depth (feet bgs)	Ground Surface Elevation (feet msl)	Top of Casing Elevation (feet msl)	Top of Screen Depth (feet bgs)	Bottom of Screen Depth (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Casing Type	Casing Diameter (inches)	Construction Date	Drill Method	Borehole Diameter (inches)	Decommissioning Date	Current Condition
E	IR39	IR39MW23A	A	449960.44	1459396.17	21.5	6.45	5.61	6.0	21.0	0.45	-14.55	PVC	4	9/7/94	ACH	10		Inspected April 2001; may need new well plug
E	IR39	IR39MW24A	A	450029.54	1459497.72	16.5	5.91	4.80	6.0	16.0	-0.09	-10.09	PVC	4	9/8/94	ACH	10		Inspected April 2000; NPI
E	IR39	IR39MW33A	A	449655.00	1459322.00	24.5	4.88	4.31	6.0	24.0	-1.12	-19.12	PVC	4	12/14/95	ACH	10		Inspected April 2000; vault repaired January 4, 2001
E	IR39	IR39MW35A	A	449872.00	1459400.00	26.5	6.09	5.56	6.0	26.0	0.09	-19.91	PVC	4	12/14/95	ACH	10		Well contains product; vault repaired January 29, 2001
E	IR39	IR39MW36A	A	449917.00	1459544.00	26.5	5.28	4.66	6.0	26.0	-0.72	-20.72	PVC	4	12/14/95	ACH	10		Inspected April 2000; NPI
E	IR39	PA39MW03A	A	450184.78	1458687.99	25.5	8.89	10.46	5.0	25.5	3.89	-16.61	PVC	4	2/17/93	ACH	10		Inspected April 2000; NPI
E	IR50	PA50MW08A	A	448959.93	1460838.13	13.0	8.02	7.48	5.0	13.0	3.02	-4.98	PVC	4	4/14/93	ACH	10		Inspected April 2000; NPI
E	IR50	PA50MW09A	A	449927.09	1459573.18	15.5	5.44	5.00	5.0	15.0	0.44	-9.56	PVC	4	4/14/93	ACH	10		Inspected April 2000; vault replaced November 16, 2000
E	IR50	PA50MW10A	A	451320.90	1459194.90	18.0	8.94	8.45	5.0	18.0	3.94	-9.06	PVC	4	4/13/93	ACH	10		Inspected April 2000; NPI
E	IR56	IR56MW39A	A	451444.10	1458903.58	21.5	10.36	9.84	6.0	21.0	4.36	-10.64	PVC	4	10/26/94	ACH	10		Inspected March 2001; may require vault repair and replacement lock
E	IR72	IR72MW32A	A	451478.00	1458760.00	21.5	10.74	10.08	6.0	21.0	4.74	-10.26	PVC	4	10/10/95	ACH	10		Inspected March 2001; needs replacement lock
E	IR72	IR72MW33A	A	451726.00	1458282.00	21.5	12.53	12.05	6.0	21.0	6.53	-8.47	PVC	4	10/10/95	ACH	10		Inspected April 2000; NPI
E	IR72	IR72P33AA	A	451732.00	1458291.00	21.5	12.58	12.07	6.0	21.0	6.58	-8.42	PVC	2	7/11/96	HSA	8		Inspected August 2001; NPI
E	IR72	IR72P33AB	A/B	451708.00	1458296.00	21.5	12.65	12.35	6.0	21.0	6.65	-8.35	PVC	2	7/11/96	HSA	8		Inspected August 2001; NPI
E	IR73	IR73MW04A	A	448731.00	1460898.00	21.5	14.06	13.48	6.0	21.0	8.06	-6.94	PVC	4	9/28/95	ACH	10		Inspected April 2000; NPI
E	IR74	IR74MW01A	A	451739.00	1458711.00	16.0	13.88	13.16	10.5	15.5	3.38	-1.62	PVC	4	7/11/96	HSA	10		Inspected April 2000; NPI
E	IR75	IR75MW05B	B	452234.00	1457022.00	21.5	15.96	15.57	11.0	21.0	4.96	-5.04	PVC	4	6/26/96	HSA	10		Inspected April 2000; vault replaced September 20, 2000
E	IR75	IR75P05AA	A	452241.00	1457030.00	21.5	16.07	15.34	11.0	21.0	5.07	-4.93	PVC	2	7/12/96	HSA	8		Inspected August 2001; NPI
E	IR75	IR75P05AB	A/B	452229.00	1457045.00	21.5	15.95	15.52	11.0	21.0	4.95	-5.05	PVC	2	7/12/96	HSA	8		Inspected August 2001; NPI
E	IR76	IR76MW13A	A	452147.00	1457665.00	24.5	20.04	19.69	9.0	24.0	11.04	-3.96	PVC	4	7/11/96	HSA	10		Inspected April 2000; NPI

Notes: Aquifer designations for new wells subject to change pending further hydrogeologic evaluation.
Information in shaded cells is pending field verification.

a Water-bearing zone designation subject to change pending updated hydrogeologic conceptual model.

b Decommissioning date currently not available

ACH Air casing hammer
ARCH Air rotary casing hammer
bgs Below ground surface
CFA Continuous flight auger
DPT Direct-push technology
HSA Hollow stem auger
ID Identification
IR Installation Restoration
IT IT Corporation
IW Injection well
MRD Mud rotary drill
msl Mean sea level
MW Monitoring well
NPI No problems identified
PA Preliminary assessment
POLY Polyethylene
PVC Polyvinyl chloride
R&M R&M Environmental and Infrastructure Engineering, Inc.
SS Stainless steel
-- Information not specified on well construction log

TABLE 4-2

WELLS FOR WATER LEVEL MEASUREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well			
Parcel B				
IR-06	IR06MW22A IR06MW59A1 IR06MW49F	IR06MW32A IR06MW34A	IR06MW35A IR06MW52F	IR06MW46A IR06MW50F
IR-07	IR07MW28A IR07MWS-2	IR07MW93A[a] IR07MW19A	IR07MW94A[a] IR07MW27A	IR07MW95A[a]
IR-10	IR10MW12A IR10MW29A1	IR10MW13A1 IR10MW32A	IR10MW14A IR10MW33A	IR10MW28A IR10MW31A1
IR-18	IR18MW91A[a] IR18MW92A[a]	IR18MW100B	IR18MW101B	PA18MW09A
IR-20	IR20MW17A			
IR-23	UT03MW11A	UT03MW12A		
IR-24	PA24MW02A	PA24MW03A		
IR-26	IR26MW41A IR26MW47A[a]	IR26MW43A IR26MW48A[a]	IR26MW44A	IR26MW46A[a]
IR-46	IR46MW37A IR46MW40A	IR46MW38A IR46MW41A	IR46MW39A	IR46MW43A
IR-50	PA50MW01A			
IR-61	IR61MW05A			
IR-62	IR62MW07A	IR62MW08A		
Parcel C				
IR-25	IR06MW40A IR06MW45A IR25MW37B IR25MW42B	IR06MW41A IR25MW16A IR25MW38B IR25MW900B	IR06MW42A IR25MW17A IR25MW39A	IR06MW44A IR25MW37A IR25MW39B
IR-28	IR28MW122A IR28MW123A IR28MW124A IR28MW125A IR28MW126A IR28MW128A IR28MW136A IR28MW299B IR28MW339A IR28MW396A IR28MW398A IR28MW401B IR28MW393F	IR28MW149A IR28MW150A IR28MW151A IR28MW155A IR28MW169A IR28MW170A IR28MW171A IR28MW173B IR28MW394A IR28MW396B IR28MW398B IR28MW127A IR28MW201F	IR28MW200A IR28MW217A IR28MW268A IR28MW286A IR28MW287A IR28MW298A IR28MW308A IR28MW309B IR28MW394B IR28MW397A IR28MW399B IR28MW172F	IR28MW311A IR28MW324A IR28MW326A IR28MW333A IR28MW338A IR28MW340A IR28MW314B PA28MW51A IR28MW395F IR28MW397B IR28MW400B IR28MW402F

TABLE 4-2 (Continued)

WELLS FOR WATER LEVEL MEASUREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well			
Parcel C (Continued)				
IR-29	IR29MW48A	IR29MW57A	IR29MW84A	IR29MW58F
IR-50	PA50MW03A	PA50MW04A	IR50MW13F	
IR-58	IR58MW26A	IR58MW31A	IR58MW32B	IR58MW33B
IR-64	IR64MW05A			
Parcel D				
IR-08	IR08MW44A	IR08MW38A[b]		
IR-09	IR09MW35A IR09MW36A IR09MW54B	IR09MW37A IR09MW38A IR09MW55B	IR09MW39A IR09MW44A	IR09MW52A IR09MW31A
IR-16	PA16MW17A	PA16MW18A[b]		
IR-22	IR22MW20A IR22MW16A	IR22MW15A	IR22MW07A	IR22MW08A
IR-32	PA32MW04A			
IR-33	IR33MW116A IR33MW61A IR33MW120B	IR33MW62A IR33MW63A IR33MW121B	IR33MW64A IR33MW65A	IR33MW66A PA33MW37A
IR-34	IR34MW01A IR34MW37A	IR34MW02A IR34MW37B	IR34MW36A	IR34MW36B
IR-35	IR35MW01A			
IR-36	IR36MW16A			
IR-37	IR37MW01A	IR37MW26B		
IR-38	IR38MW01A	IR38MW02A	IR38MW03A	
IR-44	IR44MW08A			
IR-39	IR39MW21A IR39MW22A	IR39MW23A IR39MW24A	IR39MW33A PA39MW01A	PA39MW02A
IR-50	PA50MW05A PA50MW09A	PA50MW06A PA50MW11A	PA50MW07A PA50MW12A	PA50MW08A IR50MW15A[b]
IR-55	IR55MW04A	IR55MW02A		
IR-67	IR67MW04A			
IR-70	IR70MW04A	IR70MW11A	IR70MW12A	
IR-71	IR71MW03A	IR71MW12B		

TABLE 4-2 (Continued)

WELLS FOR WATER LEVEL MEASUREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well			
Parcel E				
IR-01/21	IR01MW02B IR01MW03A IR01MW07A IR01MW17B IR01MW09B IR01MW16A	IR01MW26B IR01MW31A IR01MW367A IR01MW43A IR01MW44A IR01MW38A	IR01MW47B IR01MW48A IR01MW53B IR01MW58A IR01MW05A[b] IR01MW18A[b]	IR01MW62A IR01MWI-2 IR01MWI-3 IR01MWI-5[b] IR01MWI-9[b] IR01MW42A[b]
IR-02	IR02MW101A1 IR02MW114A1 IR02MW126A IR02MW127B IR02MW146A	IR02MW175A IR02MW179A IR02MW196A IR02MW206A1 IR02MW210B	IR02MW298A IR02MW299A IR02MW372A IR02MW87A IR02MW89A	IR02MW93A IR02MWB-1 IR02MWB-3 IR02MWB-5
IR-03	IR03MW218A2 IR03MW218A3	IR03MW224A IR03MW228B	IR03MW342A IR03MW371A	IR03MW218A1
IR-04	IR04MW13A	IR04MW37A	IR04MW40A	IR04MW36A
IR-12	IR12MW11A IR12MW13A	IR12MW14A IR12MW15A	IR12MW17A IR12MW20A	
IR-13	IR13MW12A			
IR-11/14/15	IR14MW09A IR15MW06A IR11MW26A	IR14MW10A IR15MW07A IR11MW27A[b]	IR14MW12A IR15MW08A IR15MW10F	IR14MW13A IR11MW25A
IR-36	IR36MW09A IR36MW11A IR36MW120B IR36MW121A IR36MW125A[b]	IR36MW123B IR36MW126A IR36MW128A IR36MW129B	IR36MW135A IR36MW14A IR36MW12A IR36MW17A	PA36MW01A PA36MW02A PA36MW08A IR36MW122A
IR-50	PA50MW10A			
IR-72	IR72MW33A[b]			
IR-74	IR74MW01A			

Notes: Wells proposed for water level measurement study (changes from Phase II GDGI noted – see below).

a Well installed as proposed in Parcel B groundwater evaluation (Tetra Tech EM Inc. 2001f) and added to water level measurement program for Phase III GDGI

b Existing well added to water level measurement program for Phase III GDGI

IR Installation Restoration

GDGI Groundwater data gaps investigation

Source: Tetra Tech EM Inc. 2001f. "Technical Memorandum, Parcel B Groundwater Evaluation." November 30.

TABLE 4-3

DATA COLLECTION REQUIREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																														Fate and Transport Data															
																															Monitored Natural Attenuation										Laboratory	Laboratory	Laboratory	Field Measurement		
	Laboratory Analysis																														Laboratory Analysis						Field Measurement									
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	Fluoride	CLP PCBs	Pesticides	SVOCs	VOCs	Ammonia Nitrogen	Cyanide	Organophosphates	Sulfide	Total Kjeldhal Nitrogen	Tritium	Gross Alpha, Gross Beta	Radionuclides	General Minerals (Calcium, Magnesium, Ferric Iron, Sodium, and Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Major Anions (Sulfate and Chloride)	Total Alkalinity	Carbonate, Bicarbonate, and Hydroxide Alkalinity	Oxygen, Dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Total Suspended Solids	Salinity	Water Level	Near-shore well; sample at low tide	**Analytes of Concern**
Parcel B - IR-06																																														
IR06MW22A																					1	1									1	1	1	1	1	1	1	1	1	1	1			1		Pentachlorophenol (SVOC), 1,4-DCB (VOC)
IR06MW32A																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR06MW59A1																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR06MW59A2																						1																			1			1		
IR25MW40A																						1																			1			1		
IR06MW48F																						1																			1			1		
IR06MW49F							1	1																																	1	1		1		
IR06MW50F							1	1																																	1	1		1		
IR06MW52F																						1																			1			1		
IR06MW53F																						1																			1			1		
IR06MW54F							1	1												1		1																			1	1		1		
IR06MW55F																						1																			1			1		
IR06MW57F																						1																			1			1		
IR06MW58F																						1																			1			1		
Total:							**3**	**3**												**1**	**1**	**12**									**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**14**	**3**		**14**		
Parcel B - IR-07																																														
UT03MW11A																												1	1	1											1	1		1		
Total:																												**1**	**1**	**1**											**1**	**1**		**1**		
Parcel B - IR-10																																														
IR25MW37A																						1									1	1	1	1	1	1	1	1	1	1	1		1	1		
IR25MW37B																						1																			1		1	1		
Total:																						**2**									**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**		**2**	**2**		
Parcel C - IR-25																																														
IR06MW34A																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR06MW35A																						1																			1			1		
IR06MW40A									1													1									1	1	1	1	1	1	1	1	1	1	1			1		
IR06MW41A											1											1									1	1	1	1	1	1	1	1	1	1	1			1		
IR06MW42A																					1	1																			1			1		

TABLE 4-3 (Continued)

DATA COLLECTION REQUIREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																														Fate and Transport Data																
	Laboratory Analysis																														Monitored Natural Attenuation Laboratory Analysis						Monitored Natural Attenuation Field Measurement				Laboratory	Laboratory	Laboratory	Field Measurement		
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	Fluoride	CLP PCBs	Pesticides	SVOCs	VOCs	Ammonia Nitrogen	Cyanide	Organophosphates	Sulfide	Total Kjeldhal Nitrogen	Tritium	Gross Alpha, Gross Beta	Radionuclides	General Minerals (Calcium, Magnesium, Ferric Iron, Sodium, and Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Major Anions (Sulfate and Chloride)	Total Alkalinity	Carbonate, Bicarbonate, and Hydroxide Alkalinity	Oxygen, Dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Total Suspended Solids	Salinity	Water Level	Near-shore well; sample at low tide	Analytes of Concern
Parcel C - IR-25 (Continued)																																														
IR06MW44A						1							1									1																			1	1	1	1		
IR06MW45A																						1																			1			1		
IR25MW11A	1						1	1					1						1		1	1																			1			1		
IR25MW15A1																			1	1	1	1									1	1	1	1	1	1	1	1	1	1	1	1		1		Aroclor-1260 (PCB), heptachlor epoxide (pesticide), 1,2-DCB and 1,4-DCB (VOCs)
IR25MW15A2											1		1		1	1			1		1	1									1	1	1	1	1	1	1	1	1	1	1	1		1		Aroclor-1260 (PCB), 1,2-DCB and 1,4-DCB (VOCs)
IR25MW16A													1						1		1	1									1	1	1	1	1	1	1	1	1	1	1	1		1		Aroclor-1260 (PCB), hexachloroethane (SVOC)
IR25MW17A																1						1																			1		1	1		
IR25MW18A																						1																			1			1		
IR25MW19A																		1	1	1		1									1	1	1	1	1	1	1	1	1	1	1			1		
IR25MW20A																		1		1		1																			1			1		
IR25MW22A																					1																				1			1		
IR25MW39A																					1	1									1	1	1	1	1	1	1	1	1	1	1		1	1		
IR25MW41A																						1									1	1	1	1	1	1	1	1	1	1	1			1		
new A well - Bld 134																			1		1	1																			1			1		
IR25MW38B																						1																			1		1	1		
IR25MW39B																						1																			1		1	1		
IR25MW42B																						1																			1		1	1		
new F well - Bld 134																						1																			1			1		
Total:						**1**	**1**	**1**	**1**		**2**		**4**		**1**	**2**		**2**	**6**	**3**	**8**	**22**									**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**23**	**4**	**6**	**23**		
Parcel C - IR-28																																														
IR28MW122A																						1																			1			1	1	
IR28MW124A																	1					1																			1	1		1	1	
IR28MW125A							1	1														1									1	1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW126A	1						1	1	1	1		1	1			1						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR28MW127A								1									1					1									1	1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW128A																			1			1																			1			1		
IR28MW129A							1	1					1						1		1																				1			1		
IR28MW136A																						1									1	1	1	1	1	1	1	1	1	1	1		1	1		

DATA COLLECTION REQUIREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data – Laboratory Analysis																													Fate and Transport Data – Monitored Natural Attenuation – Laboratory Analysis						Monitored Natural Attenuation – Field Measurement				Laboratory	Laboratory	Laboratory	Field Measurement		
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	Fluoride	CLP PCBs	Pesticides	SVOCs	VOCs	Ammonia Nitrogen	Cyanide	Organophosphates	Sulfide	Total Kjeldhal Nitrogen	Tritium	Gross Alpha, Gross Beta	Radionuclides	General Minerals (Calcium, Magnesium, Ferric Iron, Sodium, and Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Major Anions (Sulfate and Chloride)	Total Alkalinity	Carbonate, Bicarbonate, and Hydroxide Alkalinity	Oxygen, Dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Total Suspended Solids	Salinity	Water Level	Near-shore well; sample at low tide	Analytes of Concern
Parcel C - IR-28 (Continued)																																													
IR28MW149A																						1																			1		1	1	1	
IR28MW150A																						1									1	1	1	1	1	1	1	1	1	1	1			1	1	
IR28MW151A																						1									1	1	1	1	1	1	1	1	1	1	1		1	1		
IR28MW155A							1	1					1						1			1									1	1	1	1	1	1	1	1	1	1	1	1		1		Aroclor-1260 (PCB)
IR28MW169A																						1																			1			1		1,4-DCB (VOC)
IR28MW170A																						1																			1		1	1		
IR28MW171A																			1			1																			1			1	1	Aroclor-1260 (PCB)
IR28MW200A																						1																			1			1	1	
IR28MW217A																						1									1	1	1	1	1	1	1	1	1	1	1		1	1		
IR28MW268A																						1																			1			1		
IR28MW270A																						1																			1			1	1	
IR28MW272A																						1																			1			1	1	
IR28MW286A																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR28MW287A																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR28MW293A															1							1																			1			1	1	
IR28MW294A	1						1	1	1				1			1																									1			1		
IR28MW298A																						1																			1			1		
IR28MW308A																						1																			1			1		
IR28MW311A											1									1	1	1																			1	1	1	1		Heptachlor epoxide (pesticide), benzo(a)pyrene (SVOC)
IR28MW324A																						1																			1			1		
IR28MW329A																						1																			1			1		
IR28MW330A																						1																			1			1		
IR28MW331A																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR28MW335A																						1																			1			1		
IR28MW337A																						1																			1			1		
IR28MW338A																						1																			1			1		
IR28MW339A																						1																			1		1	1		
IR28MW394A																						1																			1		1	1	1	
IR28MW396A																						1									1	1	1	1	1	1	1	1	1	1	1		1	1		

TABLE 4-3 (Continued)

DATA COLLECTION REQUIREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																														Fate and Transport Data															
																															Monitored Natural Attenuation															
	Laboratory Analysis																														Laboratory Analysis						Field Measurement				Laboratory	Laboratory	Laboratory	Field Measurement		
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	Fluoride	CLP PCBs	Pesticides	SVOCs	VOCs	Ammonia Nitrogen	Cyanide	Organophosphates	Sulfide	Total Kjeldhal Nitrogen	Tritium	Gross Alpha, Gross Beta	Radionuclides	General Minerals (Calcium, Magnesium, Ferric Iron, Sodium, and Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Major Anions (Sulfate and Chloride)	Total Alkalinity	Carbonate, Bicarbonate, and Hydroxide Alkalinity	Oxygen, Dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Total Suspended Solids	Salinity	Water Level	Near-shore well; sample at low tide	Analytes of Concern
Parcel C - IR-28 (Continued)																																														
IR28MW397A																						1									1	1	1	1	1	1	1	1	1	1	1		1	1		
IR28MW398A																						1																			1		1	1		
PA28MW50A																						1									1	1	1	1	1	1	1	1	1	1	1			1	1	
PA28MW51A																						1																			1		1	1		
PA28MW52A																					1	1																			1			1		
IR58MW31A																			1			1									1	1	1	1	1	1	1	1	1	1	1		1	1		Aroclor-1260 (PCB), 1,2-DCB and 1,4-DCB (VOCs)
new A well - Bld 251																			1	1		1																			1			1		
IR28MW173B																1						1																			1		1	1		
IR28MW299B																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR28MW309B																						1																			1			1	1	
IR28MW314B																						1																			1		1	1		
IR28MW394B																						1																			1		1	1	1	
IR28MW396B																						1																			1		1	1		
IR28MW397B																						1									1	1	1	1	1	1	1	1	1	1	1		1	1		
IR28MW398B																						1																			1		1	1		
IR28MW399B																						1																			1		1	1		
IR28MW400B																						1																			1		1	1		
IR28MW401B																						1									1	1	1	1	1	1	1	1	1	1	1		1	1		
IR58MW32B																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR58MW33B																						1									1	1	1	1	1	1	1	1	1	1	1		1	1		1,4-DCB (VOC)
IR28MW172F																						1																			1			1		
IR28MW188F																						1																			1			1		
IR28MW189F																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR28MW190F																						1																			1			1		
IR28MW201F																						1																			1			1	1	
IR28MW211F																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR28MW216F																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR28MW275F																						1																			1			1		
IR28MW300F																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR28MW310F																						1																			1		1	1		

DATA COLLECTION REQUIREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																													Fate and Transport Data															
																														Monitored Natural Attenuation															
	Laboratory Analysis																													Laboratory Analysis						Field Measurement				Laboratory	Laboratory	Laboratory	Field Measurement		
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	Fluoride	CLP PCBs	Pesticides	SVOCs	VOCs	Ammonia Nitrogen	Cyanide	Organophosphates	Sulfide	Total Kjeldhal Nitrogen	Tritium	Gross Alpha, Gross Beta	Radionuclides	General Minerals (Calcium, Magnesium, Ferric Iron, Sodium, and Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Major Anions (Sulfate and Chloride)	Total Alkalinity	Carbonate, Bicarbonate, and Hydroxide Alkalinity	Oxygen, Dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Total Suspended Solids	Salinity	Water Level	Near-shore well; sample at low tide	Analytes of Concern
Parcel C - IR-28 (Continued)																																													
IR28MW312F																					1									1	1	1	1	1	1	1	1	1	1	1			1		
IR28MW393F																					1									1	1	1	1	1	1	1	1	1	1	1		1	1		
IR28MW395F																					1																			1		1	1		
IR28MW402F																					1									1	1	1	1	1	1	1	1	1	1	1		1	1		
new F well - Bld 251																					1																			1			1		
Total:							**5**	**6**	**2**	**1**	**1**	**1**	**4**		**1**	**3**	**2**		**6**	**2**	**3**	**70**									**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**27**	**72**	**5**	**27**	**72**	**14**	
Parcel C - IR-29																																													
IR29MW48A																		1																						1			1		
IR29MW57A																					1						1	1	1											1	1		1		
IR29MW56F																				1	1									1	1	1	1	1	1	1	1	1	1	1			1		
IR29MW58F																		1			1									1	1	1	1	1	1	1	1	1	1	1			1		
IR29MW59F									1																															1			1		
IR29MW72F							1	1													1																			1			1		
IR29MW85F																					1									1	1	1	1	1	1	1	1	1	1	1			1		
Total:							**1**	**1**	**1**									**2**		**1**	**5**						**1**	**1**	**1**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**7**	**1**		**7**		
Parcel C - IR-50																																													
PA50MW03A						1															1																			1			1	1	
PA50MW04A																																								1			1		
IR50MW13F																		1																						1			1		
Total:						**1**												**1**			**1**																			**3**			**3**	**1**	
Parcel C - IR-58																																													
IR58MW26A																					1									1	1	1	1	1	1	1	1	1	1	1			1		
IR58MW25F							1	1																																1	1		1		
Total:							**1**	**1**													**1**									**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**1**		**2**		
Parcel D - IR-22																																													
IR22MW07A																1																								1	1		1	1	
IR22MW08A																1																								1	1		1	1	
IR22MW15A																1																								1	1		1	1	

DATA COLLECTION REQUIREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																														Fate and Transport Data															
																															Monitored Natural Attenuation										Laboratory	Laboratory	Laboratory	Field Measurement		
	Laboratory Analysis																														Laboratory Analysis						Field Measurement									
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	Fluoride	CLP PCBs	Pesticides	SVOCs	VOCs	Ammonia Nitrogen	Cyanide	Organophosphates	Sulfide	Total Kjeldhal Nitrogen	Tritium	Gross Alpha, Gross Beta	Radionuclides	General Minerals (Calcium, Magnesium, Ferric Iron, Sodium, and Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Major Anions (Sulfate and Chloride)	Total Alkalinity	Carbonate, Bicarbonate, and Hydroxide Alkalinity	Oxygen, Dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Total Suspended Solids	Salinity	Water Level	Near-shore well; sample at low tide	Analytes of Concern
Parcel D - IR-22 (Continued)																																														
IR22MW16A																	1																								1	1		1	1	
IR22MW20A																	1																								1	1		1	1	
Total:																	**5**																								**5**	**5**		**5**	**5**	
Parcel D - IR-33 North																																														
IR33MW62A																													1	1											1	1		1		
Total:																													**1**	**1**											**1**	**1**		**1**		
Parcel D - IR-34																																														
IR34MW02A																												1	1	1											1	1		1		
IR34MW37A																												1	1	1											1	1		1		
Total:																												**2**	**2**	**2**											**2**	**2**		**2**		
Parcel D - IR-71																																														
IR71MW03A																												1	1	1											1	1		1		
Total:																												**1**	**1**	**1**											**1**	**1**		**1**		
Parcel E - IR01																																														
IR01MW03A																	1		1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1		1,4-DCB and benzene (VOCs)
IR01MW05A								1									1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		Benzene (VOC)
IR01MW07A																	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		
IR01MW16A[a]																	1		1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1	1	1	1	1	1	1	1		Benzene (VOC)
IR01MW18A								1									1		1	1	1	1	1	1	1	1	1		1	1				1							1	1		1		Phenanthrene (SVOC), benzene (VOC)
IR01MW31A																	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		Benzene and halogenated VOCs
IR01MW38A																	1		1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1	1	1	1	1	1		1	1	Benzene (VOC)
IR01MW42A																	1		1	1	1	1	1	1	1	1	1							1							1	1		1		
IR01MW43A		1																	1	1	1	1									1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1,4-DCB, benzene, and halogenated VOCs
IR01MW44A																1			1	1																					1	1		1	1	
IR01MW48A								1									1		1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Benzene (VOC)
IR01MW58A				1															1			1									1	1	1	1	1	1	1	1	1	1	1	1		1		Benzene (VOC)

TABLE 4-3 (Continued)

DATA COLLECTION REQUIREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Well No.	Analytes of Concern Data – Laboratory Analysis: Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	Fluoride	CLP PCBs	Pesticides	SVOCs	VOCs	Ammonia Nitrogen	Cyanide	Organophosphates	Sulfide	Total Kjeldhal Nitrogen	Tritium	Gross Alpha, Gross Beta	Radionuclides	Fate and Transport Data – Monitored Natural Attenuation – Laboratory Analysis: General Minerals (Calcium, Magnesium, Ferric Iron, Sodium, and Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Major Anions (Sulfate and Chloride)	Total Alkalinity	Carbonate, Bicarbonate, and Hydroxide Alkalinity	Field Measurement: Oxygen, Dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Laboratory: Total Dissolved Solids	Laboratory: Total Suspended Solids	Laboratory: Salinity	Field Measurement: Water Level	Near-shore well; sample at low tide	Analytes of Concern
Parcel E - IR01 (Continued)																																														
IR01MW62A	1	1	1	1		1	1	1	1	1		1	1			1					1										1	1	1	1	1	1	1	1	1	1	1	1		1	1	PAHs (SVOCs)
IR01MW63A				1																																					1	1		1	1	
IR01MW366A																	1		1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1	1	1	1	1	1		1		
IR01MW367A																	1		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		Benzene (VOC)
IR01MW400A																			1			1									1	1	1	1	1	1	1	1	1	1	1	1		1		
IR01MW401A																	1		1		1	1									1	1	1	1	1	1	1	1	1	1	1	1		1		
IR01MW402A																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR01MW403A																	1		1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1	1	1	1	1	1		1		
IR01MWI-2								1									1		1	1	1	1	1	1	1	1	1							1							1	1		1		
IR01MWI-3																	1		1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	1	1	1	1	1	1		1	1	PAHs (SVOCs), benzene (VOC)
IR01MWI-5								1									1		1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
IR01MWI-6																			1																						1			1		
IR01MWI-7																	1				1	1																			1	1		1	1	Benzene (VOC)
IR01MWI-8																	1				1	1																			1	1		1	1	
IR01MWI-9	1	1	1	1		1	1	1	1	1		1	1	1		1			1	1	1																				1	1		1	1	PAHs (SVOCs)
IR01MW02B								1									1		1	1	1	1	1	1	1	1	1							1							1	1	1	1		Phenanthrene (SVOC)
IR01MW09B																	1		1	1	1	1	1	1	1	1	1							1							1	1	1	1		Benzene (VOC)
IR01MW17B																	1		1	1	1	1	1	1	1	1	1							1							1	1	1	1		Bis(2-ethylhxyl)phthalate (SVOC), benzene (VOC)
IR01MW26B																	1		1	1	1	1	1	1	1	1	1							1							1	1	1	1		Benzene (VOC)
IR01MW47B																					1	1									1	1	1	1	1	1	1	1	1	1	1		1	1	1	Halogenated VOCs
IR01MW53B																	1		1	1	1	1	1	1	1	1	1							1							1	1	1	1	1	Benzene (VOC)
Total:	**2**	**3**	**2**	**4**		**2**	**2**	**8**	**2**	**2**		**2**	**2**	**1**		**3**	**23**		**27**	**23**	**27**	**28**	**20**	**20**	**20**	**20**	**20**	**4**	**6**	**6**	**19**	**19**	**19**	**27**	**19**	**19**	**19**	**19**	**19**	**19**	**33**	**30**	**11**	**33**	**12**	
Parcel E - IR02																																														
IR02MW89A	1												1															1													1	1		1		
IR02MW93A													1																1	1											1	1		1		
IR02MW97A[b]			1	1		1	1	1					1						1	1	1	1									1	1	1	1	1	1	1	1	1	1	1	1		1	1	Pentachlorophenol (SVOC)
IR02MW101A1	1						1	1					1								1																				1	1		1		Pentachlorophenol (SVOC)
IR02MW101A2				1		1																							1	1											1	1		1		
IR02MW114A1						1																							1	1											1	1		1	1	

TABLE 4-3 (Continued)

DATA COLLECTION REQUIREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data: Laboratory Analysis																														Fate and Transport Data: Monitored Natural Attenuation: Laboratory Analysis						Field Measurement				Laboratory	Laboratory	Laboratory	Field Measurement		
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	Fluoride	CLP PCBs	Pesticides	SVOCs	VOCs	Ammonia Nitrogen	Cyanide	Organophosphates	Sulfide	Total Kjeldhal Nitrogen	Tritium	Gross Alpha, Gross Beta	Radionuclides	General Minerals (Calcium, Magnesium, Ferric Iron, Sodium, and Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Major Anions (Sulfate and Chloride)	Total Alkalinity	Carbonate, Bicarbonate, and Hydroxide Alkalinity	Oxygen, Dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe^{2+})	Manganese (II) (Mn^{2+})	Total Dissolved Solids	Total Suspended Solids	Salinity	Water Level	Near-shore well; sample at low tide	Analytes of Concern
Parcel E - IR02 (Continued)																																														
IR02MW114A2	1					1	1	1	1				1																												1	1		1	1	
IR02MW114A3				1		1																																			1	1		1	1	
IR02MW126A				1					1	1						1			1			1							1	1											1	1		1	1	
IR02MW141A	1	1		1		1	1	1	1	1		1	1	1		1			1	1	1								1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	
IR02MW146A[c]			1	1									1						1		1	1									1	1	1	1	1	1	1	1	1	1	1	1		1	1	Pentachlorophenol (SVOC), benzene (VOC)
IR02MW147A												1							1		1								1	1											1	1		1	1	Pentachlorophenol (SVOC)
IR02MW149A									1			1							1										1	1											1	1		1	1	
IR02MW173A[c]			1	1																	1	1									1	1	1	1	1	1	1	1	1	1	1	1		1	1	Pentachlorophenol (SVOC), benzene (VOC)
IR02MW175A																	1		1	1	1	1							1	1											1	1		1	1	Halogenated VOCs
IR02MW179A																	1		1		1	1							1	1											1	1		1	1	Pentachlorophenol (SVOC)
IR02MW183A																	1		1		1																				1			1	1	
IR02MW206A1																	1		1			1							1	1											1	1		1	1	
IR02MW206A2																	1		1			1							1	1											1	1		1	1	
IR02MW209A																			1										1	1											1	1		1	1	
IR02MW298A	1					1	1	1	1				1																1	1											1	1		1		
IR02MW299A									1													1																			1	1		1	1	Halogenated VOCs
IR02MW300A																	1		1		1	1							1	1											1	1		1	1	
IR02MW372A																				1		1									1	1	1	1	1	1	1	1	1	1	1		1	1		Benzene and halogenated VOCs
IR02MW373A		1				1			1	1			1			1			1												1	1	1	1	1	1	1	1	1	1	1	1		1	1	
IR02MW127B																				1		1									1	1	1	1	1	1	1	1	1	1	1		1	1	1	
IR02MW210B												1							1			1																			1			1	1	Halogenated VOCs
IR02MWB-1	1		1				1	1	1				1			1			1										1	1											1	1		1	1	
IR02MWB-2	1						1	1	1	1		1	1		1	1						1							1	1											1	1		1	1	
IR02MWB-3	1	1				1	1	1	1	1		1	1			1				1	1								1	1											1	1		1	1	PAHs and pentachlorophenol (SVOCs)
IR02MWB-5													1						1										1	1											1	1		1	1	
Total:	**8**	**3**	**4**	**7**		**9**	**8**	**8**	**10**	**5**		**6**	**13**	**1**	**1**	**6**	**6**		**17**	**6**	**11**	**14**						**1**	**18**	**18**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**31**	**27**	**2**	**31**	**25**	
Parcel E - IR03																																														
IR03MW218A1[c]				1					1	1									1		1	1																			1	1	1	1	1	Phenanthrene (SVOC)
IR03MW218A2				1					1	1						1					1	1							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Benzene (VOC)

DATA COLLECTION REQUIREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																														Fate and Transport Data															
	Laboratory Analysis																														Monitored Natural Attenuation: Laboratory Analysis						Monitored Natural Attenuation: Field Measurement				Laboratory	Laboratory	Laboratory	Field Measurement		
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	Fluoride	CLP PCBs	Pesticides	SVOCs	VOCs	Ammonia Nitrogen	Cyanide	Organophosphates	Sulfide	Total Kjeldhal Nitrogen	Tritium	Gross Alpha, Gross Beta	Radionuclides	General Minerals (Calcium, Magnesium, Ferric Iron, Sodium, and Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Major Anions (Sulfate and Chloride)	Total Alkalinity	Carbonate, Bicarbonate, and Hydroxide Alkalinity	Oxygen, Dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Total Suspended Solids	Salinity	Water Level	Near-shore well; sample at low tide	Analytes of Concern
Parcel E - IR03 (Continued)																																														
IR03MW218A3				1																		1							1	1											1	1	1	1	1	Benzene (VOC)
IR03MW224A	1		1	1			1	1	1				1						1		1	1									1	1	1	1	1	1	1	1	1	1	1	1		1	1	
IR03MW225A[c]													1						1		1	1									1	1	1	1	1	1	1	1	1	1	1	1		1	1	Halogenated VOCs
IR03MW226A[c]	1	1		1			1	1	1	1		1	1			1			1		1	1																			1	1		1	1	Phenanthrene (SVOC), benzene and halogenated VOCs
IR03MW342A	1		1	1			1	1	1	1		1	1			1			1		1	1									1	1	1	1	1	1	1	1	1	1	1	1		1	1	Pentachlorophenol (SVOC), benzene (VOC)
IR03MW369A[c]			1	1									1						1		1	1									1	1	1	1	1	1	1	1	1	1	1	1		1	1	Phenanthrene and pentachlorophenol (SVOC), benzene (VOC)
IR03MW370A[c]			1	1									1						1		1	1									1	1	1	1	1	1	1	1	1	1	1	1		1	1	Phenanthrene (SVOC), benzene (VOC)
IR03MW371A[c]			1	1									1						1		1	1									1	1	1	1	1	1	1	1	1	1	1	1		1	1	Pentachlorophenol (VOC)
IR03MWO-1[c]	1		1	1			1	1	1	1		1	1			1			1		1	1									1	1	1	1	1	1	1	1	1	1	1	1		1	1	Benzene and halogenated VOCs
IR03MW228B[c]				1		1														1	1	1									1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Total:	**4**	**1**	**6**	**11**		**1**	**4**	**4**	**6**	**5**		**3**	**8**			**4**			**9**	**1**	**11**	**12**							**2**	**2**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**12**	**12**	**4**	**12**	**12**	
Parcel E - IR04																																														
IR04MW13A																						1									1	1	1	1	1	1	1	1	1	1	1			1		Halogenated VOCs
IR04MW31A			1																			1																			1	1		1		
IR04MW35A													1									1									1	1	1	1	1	1	1	1	1	1	1	1		1		Halogenated VOCs
IR04MW36A			1																																						1	1	1	1		
IR04MW37A																						1																			1			1		Halogenated VOCs
IR04MW38A																						1									1	1	1	1	1	1	1	1	1	1	1			1		
IR04MW39A																						1																			1			1		Halogenated VOCs
IR04MW40A						1				1			1																												1	1		1		
Total:			**2**			**1**				**1**			**2**									**6**									**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**8**	**4**	**1**	**8**		
Parcel E - IR05																																														
IR05MW73A																			1																						1	1		1		
IR05MW77A										1																															1	1		1		
IR05MW85A			1			1			1			1									1																				1	1		1		Phenanthrene (SVOC)
Total:			**1**			**1**			**1**	**1**		**1**							**1**		**1**																				**3**	**3**		**3**		

TABLE 4-3 (Continued)

DATA COLLECTION REQUIREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data: Laboratory Analysis																														Fate and Transport Data: Monitored Natural Attenuation: Laboratory Analysis						Fate and Transport Data: Monitored Natural Attenuation: Field Measurement				Laboratory	Laboratory	Laboratory	Field Measurement		
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	Fluoride	CLP PCBs	Pesticides	SVOCs	VOCs	Ammonia Nitrogen	Cyanide	Organophosphates	Sulfide	Total Kjeldhal Nitrogen	Tritium	Gross Alpha, Gross Beta	Radionuclides	General Minerals (Calcium, Magnesium, Ferric Iron, Sodium, and Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Major Anions (Sulfate and Chloride)	Total Alkalinity	Carbonate, Bicarbonate, and Hydroxide Alkalinity	Oxygen, Dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Total Suspended Solids	Salinity	Water Level	Near-shore well; sample at low tide	**Analytes of Concern**
Parcel E - IR11																																														
IR11MW25A																				1		1																			1			1		Halogenated VOCs
IR11MW26A																						1																			1			1		Halogenated VOCs
IR11MW27A									1													1																			1			1		Halogenated VOCs
Total:									**1**											**1**		**3**																			**3**			**3**		
Parcel E - IR12																																														
IR12MW11A																						1																			1			1		
IR12MW13A																						1									1	1	1	1	1	1	1	1	1	1	1			1		Halogenated VOCs
IR12MW14A																						1																			1			1		
IR12MW17A				1																1		1									1	1	1	1	1	1	1	1	1	1	1	1		1		Halogenated VOCs and benzene
IR12MW18A			1										1									1									1	1	1	1	1	1	1	1	1	1	1	1		1		
IR12MW19A																						1																			1			1		Halogenated VOCs
IR12MW20A			1																			1						1	1	1											1	1		1		
IR12MW21A[c]			1	1		1														1	1	1									1	1	1	1	1	1	1	1	1	1	1	1		1		Phenanthrene (SVOCs), halogenated VOCs
Total:			**3**	**2**		**1**							**1**							**2**	**1**	**8**						**1**	**1**	**1**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**8**	**4**		**8**		
Parcel E - IR14																																														
IR14MW09A												1	1							1									1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		
IR14MW10A		1	1	1		1				1			1						1		1	1						1	1	1											1	1		1		Pentachlorophenol (VOC)
IR14MW12A						1							1							1								1	1	1											1	1		1		
IR14MW13A[c]				1																	1										1	1	1	1	1	1	1	1	1	1	1	1		1		Phenanthrene (SVOC)
Total:		**1**	**1**	**2**		**2**				**1**		**1**	**3**						**1**	**2**	**2**	**1**						**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**4**	**4**		**4**		
Parcel E - IR15																																														
IR15MW06A										1					1							1																			1	1		1		Halogenated VOCs
IR15MW07A										1				1																											1	1		1		
IR15MW08A																					1										1	1	1	1	1	1	1	1	1	1	1			1		Phenanthrene (SVOC)
IR15MW09F																						1																			1			1		
IR15MW10F			1																			1																			1	1		1		
Total:			**1**							**2**				**1**	**1**						**1**	**3**									**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**5**	**3**		**5**		

DATA COLLECTION REQUIREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																													Fate and Transport Data															
	Laboratory Analysis																													Monitored Natural Attenuation – Laboratory Analysis						Monitored Natural Attenuation – Field Measurement				Laboratory	Laboratory	Laboratory	Field Measurement		
Well No.	**Aluminum**	**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Chromium VI**	**Copper**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Silver**	**Thallium**	**Zinc**	**CLP Metals**	**Fluoride**	**CLP PCBs**	**Pesticides**	**SVOCs**	**VOCs**	**Ammonia Nitrogen**	**Cyanide**	**Organophosphates**	**Sulfide**	**Total Kjeldhal Nitrogen**	**Tritium**	**Gross Alpha, Gross Beta**	**Radionuclides**	**General Minerals (Calcium, Magnesium, Ferric Iron, Sodium, and Potassium)**	**Methane, Ethane, Ethene**	**Nitrate-N, Nitrite-N**	**Major Anions (Sulfate and Chloride)**	**Total Alkalinity**	**Carbonate, Bicarbonate, and Hydroxide Alkalinity**	**Oxygen, Dissolved**	**Oxygen Reduction Potential**	**Ferrous Iron (Fe2+)**	**Manganese (II) (Mn2+)**	**Total Dissolved Solids**	**Total Suspended Solids**	**Salinity**	**Water Level**	**Near-shore well; sample at low tide**	**Analytes of Concern**
Parcel E - IR36																																														
IR36MW11A																				1		1						1													1	1		1		
IR36MW14A																						1																			1			1		
IR36MW15A																			1																						1			1		
IR36MW125A																						1																			1			1		Halogenated VOCs
IR36MW126A																						1																			1			1		Halogenated VOCs
IR36MW127A																						1																			1			1		Halogenated VOCs
IR36MW128A																				1		1																			1		1	1		
IR36MW135A						1																						1													1	1		1		
PA36MW03A[c]									1							1				1																					1	1		1		4,4' DDT (pesticide)
PA36MW04A									1											1		1																			1	1		1		Halogenated VOCs
PA36MW07A																				1		1																			1			1		Heptachlor (pestacide), halogenated VOCs
PA36MW08A																					1																				1			1		
IR36MW120B																						1																			1			1		Halogenated VOCs
IR36MW123B																						1																			1			1		Halogenated VOCs
IR36MW129B																						1																			1		1	1		
Total:						**1**			**2**							**1**			**1**	**5**	**1**	**11**						**2**													**15**	**4**	**2**	**15**		
Parcel E - IR39																																														
IR39MW21A		1																	1	1	1	1																			1	1		1		Heptachlor (pesticide), benzene (VOC)
IR39MW23A	1																																								1	1		1		
IR39MW33A				1																		1																			1	1		1		Benzene (VOC)
Total:	**1**	**1**		**1**															**1**	**1**	**1**	**2**																			**3**	**3**		**3**		
Parcel E - IR50																																														
PA50MW10A						1			1	1						1						1																			1	1		1		
Total:						**1**			**1**	**1**						**1**						**1**																			**1**	**1**		**1**		
Parcel E - IR56																																														
IR56MW39A																						1									1	1	1	1	1	1	1	1	1	1	1			1		Benzene (VOC)
Total:																						**1**									**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**			**1**		

TABLE 4-3 (Continued)

DATA COLLECTION REQUIREMENTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																														Fate and Transport Data															
	Laboratory Analysis																														Monitored Natural Attenuation										Laboratory	Laboratory	Laboratory	Field Measurement		
																															Laboratory Analysis						Field Measurement									
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	Fluoride	CLP PCBs	Pesticides	SVOCs	VOCs	Ammonia Nitrogen	Cyanide	Organophosphates	Sulfide	Total Kjeldhal Nitrogen	Tritium	Gross Alpha, Gross Beta	Radionuclides	General Minerals (Calcium, Magnesium, Ferric Iron, Sodium, and Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Major Anions (Sulfate and Chloride)	Total Alkalinity	Carbonate, Bicarbonate, and Hydroxide Alkalinity	Oxygen, Dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Total Suspended Solids	Salinity	Water Level	Near-shore well; sample at low tide	Analytes of Concern
Parcel E - IR72																																														
IR72MW32A																				1	1	1									1	1	1	1	1	1	1	1	1	1	1	1		1		
Total:																				**1**	**1**	**1**									**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		**1**		
Parcel E - IR73																																														
IR73MW04A																																									1			1		
Total:																																									**1**			**1**		
Grand Total:	**15**	**9**	**20**	**27**		**21**	**25**	**32**	**27**	**19**	**3**	**14**	**37**	**3**	**4**	**20**	**36**	**2**	**72**	**48**	**70**	**204**	**20**	**20**	**20**	**20**	**20**	**15**	**36**	**36**	**91**	**91**	**91**	**99**	**91**	**91**	**91**	**91**	**91**	**91**	**262**	**120**	**55**	**262**	**69**	

Notes: Refer to Tables 4-4, 4-5, 4-6, and 4-7 of FSP addendum for specific rationale for sampling at each well
For each well, the numeral "1" represents an individual analysis, not necessarily a discrete sample container. Refer to Table 2-1 (Appendix 2 of accompanying QAPP addendum) for specific groundwater analytical protocol (analytical method, sample volumes and containers, preservation, holding time, and so on).
In accordance with standard groundwater sampling procedures, groundwater temperature, pH, and conductivity measurements will be made with field equipment to ensure that samples are collected from representative formation water.
The wells indicated for MNA analysis will be sampled as feasible, but the total number of wells to be sampled may be reduced based on field conditions.
Turbidity will also be measured with field equipment to monitor for particulate interference.

a This well had oxygen-deficient conditions and may not be available for sampling.
b This well was silted between 10 and 50 percent and will require redevelopment prior to sampling.
c This well has has viscous free product, and may not be possible to sample.

CLP Contract laboratory program
DCB Dichlorobenzene
DDT Dichlorodiphenyltrichloroethane
HVOC Halogen volatile organic compound
IR Installation Restoration
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOC Semivolatile organic compound
TDS Total dissolved solids
VOC Volatile organic compound

QA/QC Samples:
Equipment Rinsate: One per day per parameter.
Field Duplicate: One for every 10 wells or portion thereof.
Trip Blank: One per cooler containing samples for VOC analysis.
Source Water Blank: One per source per event, as necessary
Matrix Spike/Matrix Spike Duplicate: One for every 20 wells sampled or portion thereof. Requires double volume of water to be collected.

TABLE 4-4

PARCEL B WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-06 (A-aquifer)	IR06MW22A	• VOCs (including 1,4-DCB) • Pentachlorophenol • MNA • TDS	• Evaluate shallow VOCs in vicinity of excavation A-1 at Parcel B • Assess progress of natural attenuation • Obtain data on TDS for beneficial use analysis
	IR06MW32A	• VOCs (incl. 1,4-DCB) • MNA • TDS	• Confirm the extent of VOCs in shallow groundwater at RU-C5 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR06MW59A1	• VOCs • MNA • TDS	• Evaluate shallow VOCs in vicinity of excavation A-1 at Parcel B • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR06MW59A2	• VOCs • TDS	• Evaluate deep VOCs in vicinity of excavation A-1 at Parcel B • Obtain data on TDS for analysis of beneficial use
	IR25MW40A	• VOCs • TDS	• Confirm the extent of VOCs in deeper groundwater at RU-C5 (to be screened at bottom of A-aquifer) • Obtain data on TDS for analysis of beneficial use
IR-06 (Bedrock)	IR06MW48F	• VOCs • TDS	• Confirm the extent of VOCs • Obtain data on TDS for analysis of beneficial use
	IR06MW49F	• Chromium, Cr VI • TSS • TDS	• Confirm the extent of chromium contamination • Obtain data on TDS for analysis of beneficial use
	IR06MW50F	• Chromium, Cr VI • TSS • TDS	• Confirm the extent of chromium contamination • Obtain data on TDS for analysis of beneficial use
	IR06MW52F	• VOCs • TDS	• Confirm extent of VOCs • Obtain data on TDS for analysis of beneficial use

TABLE 4-4 (Continued)

PARCEL B WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-06 (Bedrock) (cont.)	IR06MW53F	• VOCs • TDS	• Confirm extent of VOCs • Obtain data on TDS for analysis of beneficial use
	IR06MW54F	• Chromium and Cr VI • Pesticides • VOCs • TSS • TDS	• Confirm the extent of chromium contamination • Confirm the extent of pesticide contamination • Confirm extent of VOCs • Obtain data on TDS for analysis of beneficial use
	IR06MW55F	• VOCs • TDS	• Confirm the extent of VOCs • Obtain data on TDS for analysis of beneficial use
	IR06MW57F	• VOCs • TDS	• Confirm the extent of VOCs • Obtain data on TDS for analysis of beneficial use
	IR06MW58F	• VOCs • TDS	• Confirm the extent of VOCs • Obtain data on TDS for analysis of beneficial use
IR-07 (A-aquifer)	UT03MW11A	• Radionuclides • Tritium • TDS • TSS	• Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
IR-10 (A-aquifer)	IR25MW37A	• VOCs • MNA • TDS • Salinity	• Confirm the extent of VOCs in shallow groundwater at RU-C5 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
IR-10 (B-aquifer)	IR25MW37B	• VOCs • TDS • Salinity	• Evaluate geology and hydrogeology of B-aquifer • Evaluate whether chemicals from RU-C5 have migrated to the B-aquifer • Obtain data on TDS for analysis of beneficial use

TABLE 4-4 (Continued)

PARCEL B WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Notes: MNA parameters include reduced metals ferrous iron (Fe2+), ferric iron (Fe3+), and manganese (II), nitrate, nitrite, sulfate, dissolved oxygen, chloride, total alkalinity, hydroxide alkalinity, carbonate, bicarbonate, calcium, magnesium, sodium, potassium, and TDS. The wells indicated for MNA analysis will be sampled as feasible, but the total number of wells to be sampled may be reduced based on field conditions.

Radionuclides analysis refers to analysis for gross alpha, gross beta, americium-241, cesium-137, cobalt-60, europium-152, europium-154, potassium-40, radium-226, radium-228, strontium-90, uranium-233, uranium-235, and uranium-238.

Cr VI	Hexavalent chromium
DCB	Dichlorobenzene
IR	Installation Restoration
MNA	Monitored natural attenuation
MW	Monitoring well
RU	Remedial unit
TDS	Total dissolved solids
TSS	Total suspended solids
VOCs	Volatile organic compound

TABLE 4-5

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-25 (A-aquifer)	IR06MW34A	• VOCs • MNA • TDS	• Confirm the extent of VOCs in shallow groundwater at RU-C5 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR06MW35A	• VOCs • TDS	• Confirm the extent of VOCs in shallow groundwater at RU-C5 • Obtain data on TDS for analysis of beneficial use
	IR06MW40A	• Copper • VOCs • MNA • TDS	• Confirm the extent of copper • Confirm the extent of VOCs in shallow groundwater at RU-C5 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR06MW41A	• Manganese • VOCs • MNA • TDS	• Confirm the extent of manganese and VOCs in shallow groundwater at RU-C5 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR06MW42A	• SVOCs • VOCs • TDS	• Confirm the extent of VOCs and SVOCs • Obtain data on TDS for analysis of beneficial use
	IR06MW44A	• VOCs • Cadmium • Nickel • TSS • TDS • Salinity	• Confirm the extent of VOCs and metals in shallow groundwater at RU-C5 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Obtain data on TDS for analysis of beneficial use
	IR06MW45A	• VOCs • TDS	• Confirm the extent of VOCs in shallow groundwater at RU-C5 • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-25 (A-aquifer) (cont.)	IR25MW11A	• Aluminum • Chromium, Cr VI • Nickel • PCBs • SVOCs • VOCs • TDS	• Confirm the extent of metals, PCBs, and SVOCs • Confirm the extent of VOCs in shallow groundwater at RU-C5 • Obtain data on TDS for analysis of beneficial use
	IR25MW15A1	• VOCs (incl. 1,2-DCB and 1,4-DCB) • Aroclor-1260 • Heptachlor epoxide • MNA • TSS • TDS	• Confirm the extent of contaminants in shallow groundwater at RU-C5 • Concentrations of VOCs and SVOCs exceeded MCLs in multiple rounds • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR25MW15A2	• Manganese • Nickel • Thallium • Zinc • VOCs (incl. 1,2-DCB and 1,4-DCB) • SVOCs • Aroclor-1260 • MNA • TSS • TDS	• Confirm the extent of contaminants in deeper groundwater at RU-C5 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-25 (A-aquifer) (cont.)	IR25MW16A	• Nickel • VOCs • Aroclor-1260 • Hexachloroethane • MNA • TSS • TDS	• Confirm the extent of contaminants in shallow groundwater at RU-C5 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR25MW17A	• VOCs • TDS • Salinity • Zinc	• Confirm the extent of VOCs in shallow groundwater at RU-C5 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Obtain data on TDS for analysis of beneficial use
	IR25MW18A	• VOCs • TDS	• Confirm the extent of VOCs in shallow groundwater at RU-C5 • Obtain data on TDS for analysis of beneficial use
	IR25MW19A	• VOCs • MNA • Fluoride • PCBs • Pesticides • TDS	• Confirm the extent of contaminants in shallow groundwater at RU-C5 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR25MW20A	• Fluoride • Pesticides • VOCs • TDS	• Confirm the extent of contaminants in shallow groundwater at RU-C5 • Obtain data on TDS for analysis of beneficial use
	IR25MW22A	• SVOCs • TDS	• Confirm the extent of SVOCs • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-25 (A-aquifer) (cont.)	IR25MW39A	• SVOCs • VOCs • MNA • TDS • Salinity	• Confirm the extent of VOCs in shallow groundwater at RU-C5 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR25MW41A	• VOCs • MNA • TDS	• Confirm the extent of VOCs in deeper groundwater at RU-C5 (to be screened at bottom of A-aquifer) • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	New A well - Bldg 134	• PCBs • SVOCs • VOCs • TDS	• Confirm the extent of PCBs, VOCs and SVOCs • Obtain data on TDS for analysis of beneficial use
IR-25 (B-aquifer)	IR25MW38B	• VOCs • TDS • Salinity	• Evaluate geology and hydrogeology of B-aquifer • Evaluate whether chemicals from RU-C5 have migrated to the B-aquifer • Obtain data on TDS for analysis of beneficial use
	IR25MW39B	• VOCs • TDS • Salinity	• Evaluate geology and hydrogeology of B-aquifer • Evaluate whether chemicals from RU-C5 have migrated to the B-aquifer • Obtain data on TDS for analysis of beneficial use
	IR25MW42B	• VOCs • TDS • Salinity	• Evaluate geology and hydrogeology of B-aquifer and vicinity of RU-C5 • Evaluate whether chemicals from RU-C5 have migrated to the B-aquifer • Obtain data on TDS for analysis of beneficial use
IR-25 (Bedrock)	New F well – Bldg 134	• VOCs • TDS	• Confirm the extent of VOCs • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer)	IR28MW122A	• VOCs • TDS	• Confirm the extent of RU-C1 • Obtain data on TDS for analysis of beneficial use
	IR28MW124A	• Metals • VOCs • TSS • TDS	• Confirm extent of contamination in RU-C1 • Obtain data on TDS for analysis of beneficial use
	IR28MW125A	• VOCs • Chromium and Cr VI • MNA • TSS • TDS	• Confirm extent of contamination in RU-C1 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW126A	• Aluminum • Chromium and Cr VI • Copper • Lead • Mercury • Nickel • Zinc • VOCs • MNA • TDS	• Confirm extent of contamination in RU-C1 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont.)	IR28MW127A	• Metals • Cr VI • VOCs • MNA • TSS • TDS	• Confirm extent of contamination in RU-C1 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW128A	• VOCs • PCBs • TDS	• Confirm extent of contamination in RU-C1 • Obtain data on TDS for analysis of beneficial use
	IR28MW129A	• Chromium and Cr VI • Nickel • PCBs • SVOCs • TDS	• Confirm extent of chromium and nickel • Confirm extent of PCBs and SVOCs • Obtain data on TDS for analysis of beneficial use
	IR28MW136A	• VOCs • MNA • TDS • Salinity	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW149A	• VOCs • TDS • Salinity	• Confirm extent of RU-C1 • Obtain data on TDS for analysis of beneficial use
	IR28MW150A	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont.)	IR28MW151A	• VOCs • MNA • TDS • Salinity	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW155A	• VOCs • Aroclor-1260 • Chromium and Cr VI • Nickel • MNA • TSS • TDS	• Confirm extent of RU-C1 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Confirm extent of ecological RU-7 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW169A	• VOCs (including 1,4-DCB) • TDS	• Confirm extent of RU-C1 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Obtain data on TDS for analysis of beneficial use
	IR28MW170A	• VOCs • TDS • Salinity	• Confirm extent of RU-C1 • Obtain data on TDS for analysis of beneficial use
	IR28MW171A	• VOCS • Aroclor-1260 • TDS	• Confirm extent of ecological RU-3 • Obtain data on TDS for analysis of beneficial use
	IR28MW200A	• VOCs • TDS	• Confirm extent of RU-C4 and RU-C7 • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont.)	IR28MW217A	• VOCS • MNA • SALINITY • TDS	• Confirm extent of RU-C7 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW268A	• VOCs • TDS	• Confirm extent of VOCs • Obtain data on TDS for analysis of beneficial use
	IR28MW270A	• VOCs • TDS	• Confirm extent of RU-C1 • Obtain data on TDS for analysis of beneficial use
	IR28MW272A	• VOCS • TDS	• Confirm extent of RU-C4 and RU-C7 • Obtain data on TDS for analysis of beneficial use
	IR28MW286A	• VOCs • MNA • TDS	• Confirm extent of RU-C2 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW287A	• VOCs • MNA • TDS	• Confirm extent of RU-C2 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW293A	• VOCs • Thallium • TDS	• Confirm extent of RU-C4 and RU-C7 • Obtain data on TDS for analysis of beneficial use
	IR28MW294A	• Aluminum • Chromium, Cr VI • Copper • Nickel • Zinc • TDS	• Confirm extent of metals • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont.)	IR28MW298A	• VOCs • TDS	• Confirm extent of RU-C4 • Obtain data on TDS for analysis of beneficial use
	IR28MW308A	• VOCs • TDS	• Obtain data on TDS for analysis of beneficial use
	IR28MW311A	• VOCs • Benzo(a)pyrene • Heptachlor epoxide • Manganese • TSS • TDS • Salinity	• Confirm extent of RU-C4 and RU-C7 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Obtain data on TDS for analysis of beneficial use
	IR28MW324A	• VOCs • TDS	• Confirm the extent of VOCs • Obtain data on TDS for analysis of beneficial use
	IR28MW329A	• VOCs • TDS	• Confirm the extent of VOCs • Obtain data on TDS for analysis of beneficial use
	IR28MW330A	• VOCs • TDS	• Confirm the extent of VOCs • Obtain data on TDS for analysis of beneficial use
	IR28MW331A	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW335A	• VOCs • TDS	• Confirm the extent of VOCs • Obtain data on TDS for analysis of beneficial use
	IR28MW337A	• VOCs • TDS	• Confirm the extent of VOCs • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont.)	IR28MW338A	• VOCs • TDS	• Confirm the extent of VOCs • Obtain data on TDS for analysis of beneficial use
	IR28MW339A	• VOCs • TDS • Salinity	• Confirm extent of RU-C1 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Obtain data on TDS for analysis of beneficial use
	IR28MW394A	• VOCs • TDS • Salinity	• Confirm the extent of VOCs in shallow groundwater at RU-C4 • Obtain data on TDS for analysis of beneficial use
	IR28MW396A	• VOCs • MNA • TDS • Salinity	• Confirm the extent of VOCs in shallow groundwater at RU-C2 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW397A	• VOCs • MNA • TDS • Salinity	• Confirm the extent of VOCs in shallow groundwater at RU-C2 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW398A	• VOCs • TDS • Salinity	• Confirm the extent of VOCs in shallow groundwater at RU-C2 • Obtain data on TDS for analysis of beneficial use
	PA28MW50A	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont.)	PA28MW51A	• VOCs • TDS • Salinity	• Confirm extent of RU-C1 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Obtain data on TDS for analysis of beneficial use
	PA28MW52A	• SVOCs • VOCs • TDS	• Confirm the extent of VOCs and SVOCs • Obtain data on TDS for analysis of beneficial use
	IR58MW31A	• VOCs (incl. 1,2-DCB and 1,4-DCB) • Aroclor-1260 • MNA • TDS • Salinity	• Confirm extent of RU-C2 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	New A well – Bldg 251	• PCBs • Pesticides • VOCs • TDS	• Confirm extent of contamination in RU-C2 • Obtain data on TDS for analysis of beneficial use
IR-28 (B-aquifer)	IR28MW173B	• Zinc • VOCs • TDS • Salinity	• Confirm extent of RU-C1 • Obtain data on TDS for analysis of beneficial use
	IR28MW299B	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW309B	• VOCs • TDS	• Confirm extent of RU-C1 • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (B-aquifer) (cont.)	IR28MW314B	• VOCs • TDS • Salinity	• Confirm extent of RU-C1 • Obtain data on TDS for analysis of beneficial use
	IR28MW394B	• VOCs • TDS • Salinity	• Evaluate geology and hydrogeology of B-aquifer • Evaluate whether chemicals from RU-C4 have migrated to the B-aquifer • Obtain data on TDS for analysis of beneficial use
	IR28MW396B	• VOCs • TDS • Salinity	• Evaluate geology and hydrogeology of B-aquifer • Evaluate whether chemicals from RU-C2 have migrated to the B-aquifer • Obtain data on TDS for analysis of beneficial use
	IR28MW397B	• VOCs • MNA • TDS • Salinity	• Evaluate geology and hydrogeology of B-aquifer • Evaluate whether chemicals from RU-C2 have migrated to the B-aquifer • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW398B	• VOCs • TDS • Salinity	• Evaluate geology and hydrogeology of B-aquifer • Evaluate whether chemicals from RU-C2 have migrated to the B-aquifer • Obtain data on TDS for analysis of beneficial use
	IR28MW399B	• VOCs • TDS • Salinity	• Evaluate geology and hydrogeology of B-aquifer • Evaluate whether chemicals from RU-C1 have migrated to the B-aquifer • Obtain data on TDS for analysis of beneficial use
	IR28MW400B	• VOCs • TDS • Salinity	• Evaluate geology and hydrogeology of B-aquifer • Evaluate whether chemicals from RU-C1 have migrated to the B-aquifer • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (B-aquifer) (cont.)	IR28MW401B	• VOCs • MNA • TDS • Salinity	• Evaluate geology and hydrogeology of B-aquifer • Evaluate whether chemicals from RU-C1 have migrated to the B-aquifer • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR58MW32B	• VOCs • MNA • TDS	• Confirm extent of RU-C2 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings
	IR58MW33B	• VOCs (incl. 1,4-DCB) • MNA • TDS • Salinity	• Confirm extent of RU-C2 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
IR-28 (Bedrock water-bearing zone)	IR28MW172F	• VOCs • TDS	• Confirm extent of RU-C4 and RU-C7 • Obtain data on TDS for analysis of beneficial use
	IR28MW188F	• VOCs • TDS	• Confirm extent of RU-C7 • Most recent sampling event in 1995 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Obtain data on TDS for analysis of beneficial use
	IR28MW189F	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Most recent sampling event in 1995 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (Bedrock water-bearing zone) (cont.)	IR28MW190F	• VOCs • TDS	• Confirm extent of RU-C4 and RU-C7 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Obtain data on TDS for analysis of beneficial use
	IR28MW201F	• VOCs • TDS	• Confirm extent of RU-C4 and RU-C7 • Obtain data on TDS for analysis of beneficial use
	IR28MW211F	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Only one round of samples was collected for analysis of cis-1,2-dichloroethene and 1,1,2-trichloroethane • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW216F	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW275F	• VOCs • TDS	• Confirm extent of RU-C7 • Obtain data on TDS for analysis of beneficial use
	IR28MW300F	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW310F	• VOCs • TDS • Salinity	• Confirm extent of RU-C7 • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (Bedrock water-bearing zone) (cont.)	IR28MW312F	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW393F	• VOCs • MNA • TDS • Salinity	• Confirm extent of RU-C4 within deeper, competent, bedrock formation • Well installed in bedrock zone since no significant B-aquifer sediments were present at location • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR28MW395F	• VOCs • TDS • Salinity	• Evaluate geology and hydrogeology of B-aquifer • Evaluate whether chemicals from RU-C7 have migrated to the B-aquifer • Obtain data on TDS for analysis of beneficial use
	IR28MW402F	• VOCs • MNA • TDS • Salinity	• Confirm extent of RU-C4 within shallower, more weathered, bedrock formation • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	New F well – Bldg 251	• VOCs • TDS	• Confirm extent of VOCs • Obtain data on TDS for analysis of beneficial use
IR-29 (A-aquifer)	IR29MW48A	• PCBs • TDS	• Confirm the extent of PCBs • Obtain data on TDS for analysis of beneficial use
	IR29MW57A	• VOCs • Radionuclides • Tritium • TDS • TSS	• Confirm extent of RU-C4 and RU-C7 • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-29 (Bedrock water-bearing zone)	IR29MW56F	• SVOCs • VOCs • MNA • TDS	• Confirm extent of RU-C7 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR29MW58F	• PCBs • VOCs • MNA • TDS	• Confirm extent of RU-C7 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR29MW59F	• Copper • TDS	• Confirm extent of copper • Obtain data on TDS for analysis of beneficial use
	IR29MW72F	• Chromium, Cr VI • Benzene • TDS • Salinity	• Confirm benzene and chromium concentrations • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Obtain data on TDS for analysis of beneficial use
	IR29MW85F	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
IR-50 (A-aquifer)	PA50MW03A	• Cadmium • VOCs • Cyanide • TDS	• Confirm extent of RU-C1 • Obtain data on TDS for analysis of beneficial use
	PA50MW04A	• PCBs • TDS	• Confirm extent of PCBs • Obtain data on TDS for analysis of beneficial use
	IR50MW13F	• PCBs • TDS	• Confirm extent of PCBs • Obtain data on TDS for analysis of beneficial use

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-58 (A-aquifer)	IR58MW26A	• VOCs • MNA • TDS	• Confirm extent of RU-C2 • Assess progress of natural attenuation • Obtain data on TDS for analysis of beneficial use
IR-58 (Bedrock water-bearing zone)	IR58MW25F	• Chromium and Cr VI • TSS • TDS	• Confirm extent of RU-C4 and RU-C7 • Confirm chromium contamination • Conclusions from March 7, March 16, and March 23, 2000, BCT working meetings • Obtain data on TDS for analysis of beneficial use

Notes: MNA parameters include reduced metals ferrous iron (Fe2+), ferric iron (Fe3+), and manganese (II), nitrate, nitrite, sulfate, dissolved oxygen, chloride, total alkalinity, hydroxide alkalinity, carbonate, bicarbonate, calcium, magnesium, sodium, potassium, and TDS. The wells indicated for MNA analysis will be sampled as feasible, but the total number of wells to be sampled may be reduced based on field conditions.

Radionuclides analysis refers to analysis for gross alpha, gross beta, americium-241, cesium-137, cobalt-60, europium-152, europium-154, potassium-40, radium-226, radium-228, strontium-90, uranium-233, uranium-235, and uranium-238.

BCT Base Realignment and Closure Cleanup Team
Cr VI Hexavalent chromium
DCB Dichlorobenzene
HGAL Hunters Point groundwater ambient level
IR Installation Restoration
MCL Maximum contaminant level
MNA Monitored natural attenuation
MW Monitoring well
PA Preliminary assessment
PCB Polychlorinated biphenyl
RU Remedial unit
SVOC Semivolatile organic compound
TDS Total dissolved solids
TSS Total suspended solids
VOC Volatile organic compound

TABLE 4-6

PARCEL D WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-22 (A-aquifer)	IR22MW07A	• CLP Metals • TSS • TDS	• Confirm concentrations of arsenic and lead • Recommendation from December 5, 2000, BCT working meeting and December 12, 2000, BCT monthly meeting • Obtain data on TDS for analysis of beneficial use
	IR22MW08A	• CLP Metals • TSS • TDS	• Confirm concentrations of lead • Recommendation from December 5, 2000, BCT working meeting and December 12, 2000, BCT monthly meeting • Obtain data on TDS for analysis of beneficial use
	IR22MW15A	• CLP Metals • TSS • TDS	• Confirm concentrations of lead • Recommendation from December 5, 2000, BCT working meeting and December 12, 2000, BCT monthly meeting • Obtain data on TDS for analysis of beneficial use
	IR22MW16A	• CLP Metals • TSS • TDS	• Confirm concentrations of arsenic and lead • Recommendation from December 5, 2000, BCT working meeting and December 12, 2000, BCT monthly meeting • Obtain data on TDS for analysis of beneficial use
	IR22MW20A	• CLP Metals • TSS • TDS	• Confirm concentrations of arsenic and lead • Recommendation from December 5, 2000, BCT working meeting and December 12, 2000, BCT monthly meeting • Obtain data on TDS for analysis of beneficial use
IR-33 (A-aquifer)	IR33MW62A	• Radionuclides • TDS • TSS	• Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

TABLE 4-6 (Continued)

PARCEL D WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-34 (A-aquifer)	IR34MW02A	• Radionuclides • Tritium • TDS • TSS	• Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR34MW37A	• Radionuclides • Tritium • TDS • TSS	• Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
IR-71 (A-aquifer)	IR71MW03A	• Radionuclides • Tritium • TDS • TSS	• Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

Notes: Radionuclides analysis refers to analysis for gross alpha, gross beta, americium-241, cesium-137, cobalt-60, europium-152, europium-154, potassium-40, radium-226, radium-228, strontium-90, uranium-233, uranium-235, and uranium-238.

BCT Base Realignment and Cleanup Closure Team
CLP Contract Laboratory Program
IR Installation Restoration
MW Monitoring well
TDS Total dissolved solids
TSS Total suspended solids

TABLE 4-7

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (A-aquifer)	IR01MW03A	• CLP Metals • Pesticides • PCBs • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • MNA • Salinity • Tritium • TSS • TDS	• Confirm extent of landfill analytes • Confirm extent of specific metals (aluminum, copper, lead, nickel, and zinc) • Obtain data on pesticides to eliminate data gaps • Confirm extent of PCBs • Obtain data on SVOCs to eliminate data gaps • Confirm extent of 1,4-dichlorobenzene • Confirm attenuation and extent of benzene • Assess process of natural attenuation • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR01MW05A	• CLP Metals • Chromium VI • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates	• Confirm extent of landfill analytes • Confirm extent of specific metals (aluminum, antimony, arsenic, cadmium, chromium, chromium VI, copper, lead, mercury, nickel, silver, zinc) • Confirm extent of PCBs • Confirm attenuation and extent of benzene • Assess process of natural attenuation • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MW05A	• Sulfide • Total Kjeldhal Nitrogen • MNA • Radionuclides • Tritium • TSS • TDS	(see above)
	IR01MW07A	• CLP Metals • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • MNA • Radionuclides • Tritium • TSS • TDS	• Confirm extent of landfill analytes • Confirm extent of specific metals (nickel) • Assess process of natural attenuation • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MW16A	• CLP Metals • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • MNA • Salinity • TSS • TDS	• Confirm extent of landfill analytes • Confirm extent of specific metals (aluminum, copper, lead, nickel, mercury) • Confirm extent of PCBs • Confirm attenuation and extent of benzene • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR01MW18A	• CLP Metals • Chromium VI • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen	• Confirm extent of landfill analytes • Confirm extent of specific metals (aluminum, chromium, chromium VI, copper, lead, mercury, nickel, zinc) • Confirm extent of PCBs • Confirm extent of phenanthrene • Confirm attenuation and extent of benzene • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MW18A (continued)	• Major Anions • Radionuclides • TSS • TDS	(see above)
	IR01MW31A	• CLP Metals • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • MNA • Radionuclides • Tritium • TSS • TDS	• Confirm extent of landfill analytes • Confirm extent of specific metals (lead, aluminum) • Confirm extent of aluminum • Confirm extent of PCBs • Confirm attenuation and extent of benzene • Confirm attenuation and migration of HVOCs • Assess process of natural attenuation • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR01MW38A	• CLP Metals • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide	• Confirm extent of landfill analytes • Confirm attenuation and extent of benzene • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MW38A (continued)	• Organophosphates • Sulfide • Total Kjeldhal Nitrogen • MNA • TSS • TDS	(see above)
	IR01MW42A	• CLP Metals • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • Sulfate, Chloride • TSS • TDS	• Confirm extent of landfill analytes • Confirm extent of specific metals (lead) • Evaluate extent of migration of VOCs • Obtain data on TDS for analysis of beneficial use
	IR01MW43A	• Antimony • PCBs • Pesticides • SVOCs • VOCs • MNA	• Confirm extent of antimony • Confirm extent of PCBs • Confirm extent of pesticides; Obtain data on pesticides to eliminate data gaps • Confirm extent of 1,4-dichlorobenzene • Obtain data on SVOCs to eliminate data gaps • Confirm attenuation and extent of HVOCs, VOCs, and benzene

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MW43A (continued)	• Salinity • TSS • TDS	• Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR01MW44A	• Zinc • PCBs • Pesticides • TSS • TDS	• Confirm extent of listed metals • Confirm extent of PCBs • Confirm extent of pesticides • Obtain data on TDS for analysis of beneficial use
	IR01MW48A	• CLP Metals • Chromium VI • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • MNA • Salinity • TSS • TDS	• Confirm extent of landfill analytes • Confirm extent of specific metals (aluminum, barium, chromium, chromium VI, copper, lead, zinc) • Confirm attenuation and extent of benzene • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MW58A	• Barium • PCBs • VOCs • MNA • TSS • TDS	• Confirm extent of barium • Confirm extent of PCBs and benzene • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR01MW62A	• Metals • Chromium VI • SVOCs • MNA • TSS • TDS	• Confirm extent of specific metals (aluminum, antimony, arsenic, barium, cadmium, chromium, chromium VI, copper, lead, mercury, nickel, zinc) • Confirm extent of PAHs and SVOCs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR01MW63A	• Barium • TSS • TDS	• Confirm extent of barium • Obtain data on TDS for analysis of beneficial use
	IR01MW366A	• CLP Metals • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide	• Confirm extent of landfill analytes • Confirm extent of specific metals (cadmium, copper, mercury, nickel, zinc) • Confirm extent of SVOCs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MW366A (continued)	• Organophosphates • Sulfide • Total Kjeldhal Nitrogen • MNA • TSS • TDS	(see above)
	IR01MW367A	• CLP Metals • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • MNA • Radionuclides • TSS • TDS	• Confirm extent of landfill analytes • Confirm extent of specific metals (zinc) • Confirm extent of pesticides • Confirm attenuation and extent of benzene; evaluate migration of VOCs • Assess process of natural attenuation • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR01MW400A	• PCBs • VOCs • MNA • TSS • TDS	• Confirm extent of PCBs and VOCs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MW401A	• CLP Metals • VOCs • SVOCs • PCBs • MNA • TSS • TDS	• Evaluate wells at site periphery • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR01MW402A	• VOCs • MNA • TDS	• Confirm extent of VOCs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR01MW403A	• CLP Metals • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • MNA • TSS • TDS	• Confirm extent of landfill analytes • Evaluate wells at site periphery for VOCs, SVOCs, and metals • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MWI-2	• CLP Metals • Chromium VI • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • Sulfate, Chloride • TSS • TDS	• Confirm extent of landfill analytes • Confirm extent of specific metals (aluminum, arsenic, barium, beryllium, chromium, chromium VI, copper, lead, mercury, nickel, zinc) • Obtain data on TDS for analysis of beneficial use
	IR01MWI-3	• CLP Metals • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • MNA • TSS • TDS	• Confirm extent of landfill analytes • Confirm extent of specific metals (nickel, zinc) • Confirm extent of PCBs • Confirm extent of PAHs • Confirm attenuation and extent of benzene • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MWI-5	• CLP Metals • Chromium VI • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • MNA • Salinity • Radionuclides • TSS • TDS	• Confirm extent of landfill analytes • Confirm extent of specific metals (antimony, barium, chromium, chromium VI, copper, lead, mercury, nickel, zinc) • Confirm extent of PCBs and pesticides • Confirm extent of SVOCs • Confirm attenuation and extent of benzene • Assess process of natural attenuation • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR01MWI-6	• PCBs • TDS	• Confirm extent of PCBs • Obtain data on TDS for analysis of beneficial use
	IR01MWI-7	• CLP Metals • VOCs • SVOCs • TSS • TDS	• Evaluate wells near shore • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MWI-8	• CLP Metals • VOCs • SVOCs • TSS • TDS	• Evaluate wells near shore • Obtain data on TDS for analysis of beneficial use
	IR01MWI-9	• Metals • Chromium VI • PCBs • SVOCs • Pesticides • TSS • TDS	• Confirm extent of specific metals (aluminum, antimony, arsenic, barium, cadmium, chromium, chromium VI, copper, lead, mercury, nickel, silver, zinc) • Confirm extent of PCBs • Confirm extent of PAHs • Obtain data on SVOCs to eliminate data gaps • Obtain data on pesticides to eliminate data gaps • Obtain data on TDS for analysis of beneficial use
IR-01 (B-aquifer)	IR01MW02B	• CLP Metals • Chromium VI • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates	• Confirm extent of landfill analytes • Confirm extent of specific metals (aluminum, chromium, chromium VI) • Confirm extent of phenanthrene • Evaluate possible migration from A-aquifer • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (B-aquifer) (cont.)	IR01MW02B (continued)	• Sulfide • Total Kjeldhal Nitrogen • Sulfate, Chloride • Salinity • TSS • TDS	(see above)
	IR01MW09B	• CLP Metals • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • Sulfate, Chloride • TSS • TDS • Salinity	• Confirm extent of landfill analytes • Evaluate possible benzene migration and VOCs from A-aquifer • Obtain data on TDS for analysis of beneficial use
	IR01MW17B	• CLP Metals • PCBs • Pesticides • SVOCs	• Confirm extent of landfill analytes • Confirm extent of specific metals (aluminum, antimony, cadmium) • Evaluate possible PCB and benzene migration • VOCs from A-aquifer

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (B-aquifer) (cont.)	IR01MW17B (continued)	• VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • Sulfate, Chloride • Salinity • TSS • TDS	• Confirm presence or extent of bis(2-ethylhexyl) phthalate • Obtain data on TDS for analysis of beneficial use
	IR01MW26B	• CLP Metals • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • Sulfate, Chloride • Salinity • TSS • TDS	• Confirm extent of landfill analytes • Evaluate possible migration of benzene and VOCs from A-aquifer • Obtain data on SVOCs to eliminate data gaps • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-01 (B-aquifer) (cont.)	IR01MW47B	• VOCs • SVOCs • MNA • Salinity • TDS	• Confirm extent and attenuation of HVOCs • Obtain data on SVOCs to eliminate data gaps • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR01MW53B	• CLP Metals • PCBs • Pesticides • SVOCs • VOCs • Ammonia Nitrogen • Cyanide • Organophosphates • Sulfide • Total Kjeldhal Nitrogen • Sulfate, Chloride • Salinity • TSS • TDS	• Confirm extent of landfill analytes • Confirm extent of cadmium • Evaluate possible migration of benzene and VOCs from A-aquifer • Obtain data on TDS for analysis of beneficial use
IR-02 (A-aquifer)	IR02MW89A	• Aluminum • Nickel • Tritium • TSS • TDS	• Confirm extent of aluminum and nickel • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-02 (A-aquifer) (cont.)	IR02MW93A	• Nickel • Radionuclides • TSS • TDS	• Confirm extent of nickel • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MW97A	• Cadmium • Chromium, Chromium VI • Pesticides • PCBs, VOCs, SVOCs • Barium, Arsenic, Nickel • MNA • TSS • TDS	• Confirm extent of cadmium, chromium and chromium VI • Confirm extent of pesticides • Confirm extent of IR03 plumes: PCBs, barium, arsenic, nickel, VOCs, and pentachlorophenol • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR02MW101A1	• Metals • Chromium VI • SVOCs • TSS • TDS	• Confirm the extent of specific metals (aluminum, chromium, chromium VI, nickel) • Confirm extent of pentachlorophenol • Obtain data on TDS for analysis of beneficial use
	IR02MW101A2	• Metals • Radionuclides • TSS • TDS	• Confirm extent of specific metals (barium, cadmium) • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MW114A1	• Cadmium • Radionuclides • TSS • TDS	• Confirm extent of cadmium • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-02 (A-aquifer) (cont.)	IR02MW114A2	• Metals • Chromium VI • TSS • TDS	• Confirm extent of specific metals (aluminum, cadmium, chromium, chromium VI, copper, nickel) • Obtain data on TDS for analysis of beneficial use
	IR02MW114A3	• Barium • Cadmium • TSS • TDS	• Confirm extent of listed metals • Obtain data on TDS for analysis of beneficial use
	IR02MW126A	• Metals • PCBs • VOCs • Radionuclides • TSS • TDS	• Confirm extent of specific metals (barium, copper, lead, zinc) • Confirm extent of PCBs and VOCs • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MW141A	• Metals • Chromium VI • PCBs • SVOCs • Pesticides • MNA • Radionuclides • TSS • TDS	• Confirm extent of specific metals (aluminum, antimony, barium, cadmium, chromium, chromium VI, copper, lead, mercury, nickel, silver, zinc) • Confirm extent of PCBs • Obtain data on SVOCs to eliminate data gaps • Obtain data on pesticides to eliminate data gaps • Assess process of natural attenuation • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-02 (A-aquifer) (cont.)	IR02MW146A	• PCBs • VOCs • SVOCs • Barium, Arsenic, Nickel • MNA • TSS • TDS	• Confirm extent of PCBs • Confirm attenuation and extent of benzene • Confirm extent of IR03 plumes: pentachlorophenol, listed metals, VOCs, and PCBs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR02MW147A	• SVOCs • PCBs • Mercury • Radionuclides • TSS • TDS	• Confirm extent of pentachlorophenol • Obtain data for PCBs and mercury to assist sediment characterization • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MW149A	• Copper • Mercury • PCBs • Radionuclides • TSS • TDS	• Confirm extent of listed metals • Obtain data for PCBs and mercury to assist sediment characterization • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MW173A	• Arsenic • Barium • SVOCs • VOCs • MNA • TSS • TDS	• Confirm extent of listed metals • Confirm extent of phenanthrene • Confirm attenuation and extent of benzene • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

**PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA**

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-02 (A-aquifer) (cont.)	IR02MW175A	• CLP Metals • VOCs • SVOCs • PCBs • Pesticides • Radionuclides • TSS • TDS	• Confirm extent of aluminum • Confirm attenuation and extent of HVOCs • Obtain data on SVOCs to eliminate data gaps • Obtain data on pesticides to eliminate data gaps • Obtain data for PCBs and metals to assist sediment characterization • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MW179A	• CLP Metals • PCBs • VOCs • SVOCs • Radionuclides • TSS • TDS	• Confirm extent of CLP metals • Confirm extent of VOCs at IR02MW175A • Confirm extent of pentachlorophenol at IR02MW183A • Obtain data for PCBs and metals to assist sediment characterization • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MW183A	• CLP Metals • SVOCs • PCBs • TDS	• Confirm extent of metals and pentachlorophenol • Obtain data for PCBs to assist sediment characterization • Obtain data on TDS for analysis of beneficial use
	IR02MW206A1	• CLP Metals • VOCs • PCBs • Radionuclides • TSS • TDS	• Confirm extent of VOCs near IR02MW175A • Obtain data for PCBs and metals to assist sediment characterization • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-02 (A-aquifer) (cont.)	IR02MW206A2	• CLP Metals • VOCs • PCBs • Radionuclides • TSS • TDS	• Confirm extent of VOCs near IR02MW175A • Obtain data for PCBs and metals to assist sediment characterization • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MW209A	• PCBs • Radionuclides • TSS • TDS	• Obtain data for PCBs to assist sediment characterization • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MW298A	• Aluminum • Cadmium • Chromium, Chromium VI • Copper • Nickel • Radionuclides • TSS • TDS	• Confirm extent of metals at IR02MW114A2 • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MW299A	• Copper • VOCs • TSS • TDS	• Confirm extent of listed metals • Confirm attenuation and extent of HVOCs • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-02 (A-aquifer) (cont.)	IR02MW300A	• CLP Metals • PCBs • VOCs • SVOCs • Radionuclides • TSS • TDS	• Confirm extent of CLP metals • Confirm extent of VOCs near IR02MW175A • Obtain data on SVOCs to eliminate data gaps • Obtain data for PCBs and metals to assist sediment characterization • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MW372A	• Pesticides • VOCs • MNA • Salinity • TDS	• Confirm extent of pesticides • Confirm attenuation and extent of benzene and HVOCs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR02MW373A	• Metals • PCBs • MNA • TSS • TDS	• Confirm extent of specific metals (antimony, cadmium, copper, lead, nickel, zinc) • Confirm extent of PCBs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR02MWB-1	• Metals • Chromium VI • PCBs • Radionuclides • TSS • TDS	• Confirm extent of specific metals (aluminum, arsenic, chromium, chromium VI, copper, nickel, zinc) • Obtain PCBs and mercury data to assist sediment characterization • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-02 (A-aquifer) (cont.)	IR02MWB-2	• Metals • Chromium VI • VOCs • PCBs • Radionuclides • TSS • TDS	• Confirm extent of specific metals (aluminum, chromium, chromium VI, copper, lead, mercury, nickel, thallium, zinc) • Confirm attenuation and extent of HVOCs • Obtain data for PCBs to assist sediment characterization • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MWB-3	• Metals • Chromium VI • SVOCs • Pesticides • Radionuclides • TSS • TDS	• Confirm extent of specific metals (aluminum, antimony, cadmium, chromium, chromium VI, copper, lead, mercury, nickel, zinc) • Confirm extent of PAHs and pentachlorophenol • Obtain data on SVOCs to eliminate data gaps • Obtain data on pesticides to eliminate data gaps • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR02MWB-5	• Nickel • PCBs • Radionuclides • TSS • TDS	• Confirm extent of listed metals • Confirm extent of PCBs • Obtain data for PCBs to assist sediment characterization • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
IR-02 (B-aquifer)	IR02MW127B	• VOCs, pesticides • MNA • Salinity • TDS	• Assess migration from A-aquifer • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-02 (B-aquifer) (cont.)	IR02MW210B	• Mercury • PCBs • VOCs • TDS	• Evaluate possible migration of HVOCs from A aquifer • Obtain data on TDS for analysis of beneficial use
IR-03 (A-aquifer)	IR03MW218A1	• Barium • Copper • Lead • PCBs • SVOCs • VOCs • Salinity • TSS • TDS	• Confirm extent of listed metals • Confirm extent of PCBs and VOCs • Confirm extent of phenanthrene • Obtain data on TDS for analysis of beneficial use
	IR03MW218A2	• Barium • Copper • Lead • Zinc • SVOCs • VOCs • MNA • Salinity • Radionuclides • TSS • TDS	• Confirm extent of listed metals • Confirm extent of SVOCs and benzene • Assess process of natural attenuation • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-03 (A-aquifer) (cont.)	IR03MW218A3	• Barium • VOCs • Salinity • Radionuclides • TSS • TDS	• Confirm extent of barium • Confirm attenuation and extent of benzene • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR03MW224A	• Aluminum • Chromium, Chromium VI • Copper • SVOCs • VOCs • Arsenic, barium, nickel • MNA • PCBs • TSS • TDS	• Confirm extent of listed metals • Confirm extent of contamination at IR03: SVOCs, VOCs, arsenic, barium, nickel • Obtain data on SVOCs to eliminate data gaps • Assess process of natural attenuation • Confirm extent of PCBs • Obtain data on TDS for analysis of beneficial use
	IR03MW225A	• Nickel • PCBs • SVOCs • VOCs • MNA • TSS • TDS	• Confirm extent of listed metals • Confirm extent of PCBs • Confirm extent of SVOCs • Confirm extent of HVOCs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-03 (A-aquifer) (cont.)	IR03MW226A	• Metals • Chromium VI • PCBs • SVOCs • VOCs • TSS • TDS	• Confirm extent of specific metals (aluminum, antimony, barium, chromium, chromium VI, copper, lead, mercury, nickel, zinc) • Confirm extent of PCBs • Confirm extent of phenanthrene • Confirm attenuation and extent of HVOCs and benzene • Obtain data on TDS for analysis of beneficial use
	IR03MW342A	• Metals • Chromium VI • SVOCs • VOCs • PCBs • MNA • TSS • TDS	• Confirm extent of specific metals (aluminum, arsenic, barium, chromium, chromium VI, copper, lead, mercury, nickel, zinc) • Confirm extent of IR03 plumes: pentachlorophenol and PCB • Confirm attenuation and extent of benzene and plumes at IR03 • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR03MW369A	• SVOCs • VOCs • PCBs • Barium, Arsenic, Nickel • MNA • TSS • TDS	• Confirm extent of phenanthrene • Confirm attenuation and extent of benzene • Confirm extent of plumes at IR03: pentachlorophenol, listed metals, VOCs and PCBs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-03 (A-aquifer) (cont.)	IR03MW370A	• Barium, Arsenic, Nickel • PCBs • SVOCs • VOCs • MNA • TSS • TDS	• Confirm extent of barium and metals at IR03 plume • Confirm extent of PCBs from plume at IR03 • Confirm extent of phenanthrene • Confirm attenuation and extent of benzene • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR03MW371A	• PCBs • VOCs • SVOCs • Barium, Arsenic, Nickel • MNA • TSS • TDS	• Confirm extent of PCBs • Confirm extent of plumes at IR03: pentachlorophenol, listed metals, VOCs, and PCBs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR03MWO-1	• Metals • Chromium VI • PCBs • SVOCs • VOCs • MNA • TDS, TSS	• Confirm extent of specific metals (aluminum, arsenic, barium, chromium, chromium VI, copper, lead, mercury, nickel, zinc) and of plume at IR03 • Confirm extent of PCBs • Confirm extent of SVOCs • Confirm attenuation and extent of benzene • Confirm attenuation and extent of HVOCs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-03 (B-aquifer)	IR03MW228B	• Cadmium • Barium • VOCs • SVOCs • Pesticides • MNA • Salinity • TDS and TSS	• Confirm extent of cadmium • Evaluate migration from A-aquifer • Obtain data on SVOCs to eliminate data gaps • Obtain data on pesticides to eliminate data gaps • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
IR-04 (A-aquifer)	IR04MW13A	• VOCs • MNA • TDS	• Confirm attenuation and extent of HVOCs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR04MW31A	• Arsenic • VOCs • TSS • TDS	• Confirm extent of arsenic • Evaluate migration from A-aquifer • Obtain data on TDS for analysis of beneficial use
	IR04MW35A	• Nickel • VOCs • MNA • TDS • TSS	• Confirm extent of nickel • Confirm attenuation and extent of HVOCs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR04MW36A	• Arsenic • Salinity • TDS • TSS	• Confirm extent of arsenic • Obtain data on TDS for analysis of beneficial use
	IR04MW37A	• VOCs • TDS	• Confirm attenuation and extent of HVOCs • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-04 (A-aquifer)	IR04MW38A	• VOCs • MNA • TDS	• Evaluate potential for migration of VOCs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR04MW39A	• VOCs • TDS	• Confirm attenuation and extent of HVOCs • Obtain data on TDS for analysis of beneficial use
	IR04MW40A	• Lead • Nickel • Cadmium • TDS • TSS	• Confirm extent of listed metals • Obtain data on TDS for analysis of beneficial use
IR-05 (A-aquifer)	IR05MW73A	• PCBs • TSS • TDS	• Confirm extent of PCBs • Obtain data on TDS for analysis of beneficial use
	IR05MW77A	• Lead • TDS • TSS	• Confirm extent of lead • Obtain data on TDS for analysis of beneficial use
	IR05MW85A	• Arsenic • Cadmium • Copper • Mercury • SVOCs • TSS • TDS	• Confirm extent of listed metals • Confirm extent of phenanthrene • Obtain data on TDS for analysis of beneficial use
IR-11 (A-aquifer)	IR11MW25A	• VOCs • Pesticides • TDS	• Confirm attenuation and extent of HVOCs • Obtain data on pesticides to eliminate data gaps • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-11 (A-aquifer) (cont.)	IR11MW26A	• VOCs • TDS	• Confirm attenuation and extent of HVOCs • Obtain data on TDS for analysis of beneficial use
	IR11MW27A	• Copper • VOCs • TDS	• Confirm extent of copper • Confirm attenuation and extent of HVOCs • Obtain data on TDS for analysis of beneficial use
IR-12 (A-aquifer)	IR12MW11A	• VOCs • TDS	• Evaluate potential for migration of VOCs • Obtain data on TDS for analysis of beneficial use
	IR12MW13A	• VOCs • MNA • TDS	• Confirm attenuation and extent of HVOCs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR12MW14A	• VOCs • TDS	• Evaluate potential for migration of VOCs • Obtain data on TDS for analysis of beneficial use
	IR12MW17A	• Barium • VOCs • Pesticides • MNA • TSS • TDS	• Confirm extent of barium • Confirm attenuation and extent of HVOCs • Confirm extent and attenuation of benzene • Obtain data on pesticides to eliminate data gaps • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
	IR12MW18A	• Arsenic • Nickel • VOCs • MNA • TSS • TDS	• Confirm extent of listed metals • Evaluate potential for migration of VOCs • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-12 (A-aquifer) (cont.)	IR12MW19A	• VOCs • TDS	• Confirm attenuation and extent of HVOCs • Obtain data on TDS for analysis of beneficial use
	IR12MW20A	• Arsenic • VOCs • Radionuclides • Tritium • TSS • TDS	• Confirm extent of arsenic • Evaluate potential for migration of VOCs • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR12MW21A	• Arsenic • Barium • Cadmium • VOCs • SVOCs • Pesticides • MNA • TSS • TDS	• Confirm extent of listed metals • Evaluate possible migration of HVOCs • Obtain data on SVOCs to eliminate data gaps; • Confirm extent of phenanthrene • Obtain data on pesticides to eliminate data gaps • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
IR-14 (A-aquifer)	IR14MW09A	• Mercury • Nickel • Pesticides • MNA • Radionuclides • TSS • TDS	• Confirm extent of listed metals • Obtain data on pesticides to eliminate data gaps • Assess process of natural attenuation • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-14 (A-aquifer) (cont.)	IR14MW10A	• Antimony • Cadmium • Lead • PCBs • VOCs • SVOCs • Arsenic, Barium, Nickel • Radionuclides • Tritium • TSS • TDS	• Confirm extent of listed metals • Confirm extent of IR03 plumes including PCBs, barium, arsenic, nickel, VOCs, and pentachlorophenol • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR14MW12A	• Cadmium • Nickel • Pesticides • Radionuclides • Tritium • TSS • TDS	• Confirm extent of cadmium and nickel • Obtain data on pesticides to eliminate data gaps • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR14MW13A	• Barium • SVOCs • MNA • TSS • TDS	• Confirm extent of barium • Confirm extent of phenanthrene • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-15 (A-aquifer)	IR15MW06A	• Lead • Thallium • VOCs • TSS • TDS	• Confirm extent of listed metals • Confirm attenuation and extent of HVOCs • Obtain data on TDS for analysis of beneficial use
	IR15MW07A	• Lead • Silver • TSS • TDS	• Confirm extent of lead and silver • Obtain data on TDS for analysis of beneficial use
	IR15MW08A	• MNA • SVOCs • TDS	• Assess process of natural attenuation • Confirm extent of phenanthrene; Obtain data on SVOCs to eliminate data gaps • Obtain data on TDS for analysis of beneficial use
IR-15 (Bedrock)	IR15MW09F	• VOCs • TDS	• Evaluate potential for migration of VOCs • Obtain data on TDS for analysis of beneficial use
	IR15MW10F	• Arsenic • VOCs • TSS • TDS	• Confirm extent of arsenic • Evaluate potential for migration of VOCs • Obtain data on TDS for analysis of beneficial use
IR-36 (A-aquifer)	IR36MW11A	• VOCs • Pesticides • Tritium • TSS • TDS	• Evaluate potential for migration of VOCs • Obtain data on pesticides to eliminate data gaps • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
	IR36MW14A	• VOCs • TDS	• Confirm extent of VOCs to the north • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-36 (A-aquifer) (cont.)	IR36MW15A	• PCBs • TDS	• Confirm extent of PCBs • Obtain data on TDS for analysis of beneficial use
	IR36MW125A	• VOCs • TDS	• Confirm attenuation and extent of HVOCs • Obtain data on TDS for analysis of beneficial use
	IR36MW126A	• VOCs • TDS	• Evaluate possible migration of HVOCs other wells • Obtain data on TDS for analysis of beneficial use
	IR36MW127A	• VOCs • TDS	• Evaluate possible migration of HVOCs other wells • Obtain data on TDS for analysis of beneficial use
	IR36MW128A	• VOCs • Pesticides • Salinity • TDS	• Confirm extent of VOCs to the north • Obtain data on pesticides to eliminate data gaps • Obtain data on TDS for analysis of beneficial use
	IR36MW135A	• Cadmium • Tritium • TSS • TDS	• Confirm extent of cadmium • Obtain data on TDS for analysis of beneficial use
	PA36MW03A	• Copper • Zinc • Pesticides • TDS, TSS	• Confirm extent of listed metals • Confirm extent of 4,4'-DDT • Obtain data on TDS for analysis of beneficial use
	PA36MW04A	• Copper • Pesticides • VOCs • TDS • TSS	• Confirm extent of copper • Confirm extent of pesticides • Confirm extent or attenuation of HVOCs • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-36 (A-aquifer) (cont.)	PA36MW07A	• Pesticides • VOCs • TDS	• Confirm reduction of heptachlor • Confirm extent or attenuation of HVOCs • Obtain data on TDS for analysis of beneficial use
	PA36MW08A	• SVOCs • TDS	• Obtain data on SVOCs to eliminate data gaps • Obtain data on TDS for analysis of beneficial use
IR-36 (B-aquifer)	IR36MW120B	• VOCs • TDS	• Evaluate possible migration of HVOCs from A aquifer • Obtain data on TDS for analysis of beneficial use
	IR36MW123B	• VOCs • TDS	• Evaluate possible migration of HVOCs from A aquifer • Obtain data on TDS for analysis of beneficial use
	IR36MW129B	• VOCs • TDS • Salinity	• Evaluate possible migration of HVOCs from A aquifer • Obtain data on TDS for analysis of beneficial use
IR-39 (A-aquifer)	IR39MW21A	• Antimony • PCBs • Pesticides • SVOCs • VOCs • TSS • TDS	• Confirm extent of antimony • Confirm extent of heptachlor; Obtain pesticides data to eliminate data gaps • Confirm extent or attenuation of benzene • Obtain data on SVOCs to eliminate data gaps • Confirm extent of PCBs • Obtain data on TDS for analysis of beneficial use
	IR39MW23A	• Aluminum • TSS • TDS	• Confirm extent of aluminum • Obtain data on TDS for analysis of beneficial use
	IR39MW33A	• Barium • VOCs • TSS • TDS	• Confirm extent of barium • Confirm extent and attenuation of benzene • Obtain data on TDS for analysis of beneficial use

TABLE 4-7 (Continued)

PARCEL E WELLS FOR RESAMPLING
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-50 (A-aquifer)	PA50MW10A	• Metals • VOCs • TSS • TDS	• Confirm extent of specific metals (cadmium, copper, lead, zinc) • Evaluate possible migration of VOCs • Obtain data on TDS for analysis of beneficial use
IR-56 (A-aquifer)	IR56MW39A	• VOCs • MNA • TDS	• Confirm extent and attenuation of benzene • Assess process of natural attenuation • Obtain data on TDS for analysis of beneficial use
IR-72 (A-aquifer)	IR72MW32A	• VOCs • SVOCs • MNA • Pesticides • TSS • TDS	• Evaluate possible migration of VOCs • Obtain data on SVOCs to eliminate data gaps • Assess process of natural attenuation • Obtain data on pesticides to eliminate data gaps • Data gap sampling for radionuclides • Obtain data on TDS for analysis of beneficial use
IR-73 (A-aquifer)	IR73MW04A	• TDS	• Obtain data on TDS for analysis of beneficial use

Notes: MNA parameters include reduced metals ferrous iron (Fe2+), ferric iron (Fe3+), and manganese (II), nitrate, nitrite, sulfate, dissolved oxygen, chloride, total alkalinity, hydroxide alkalinity, carbonate, bicarbonate, calcium, magnesium, sodium, potassium, and total dissolved solids (TDS). The wells indicated for MNA analysis will be sampled as feasible, but the total number of wells to be sampled may be reduced based on field conditions.

Radionuclides analysis refers to analysis for gross alpha, gross beta, americium-241, cesium-137, cobalt-60, europium-152, europium-154, potassium-40, radium-226, radium-228, strontium-90, uranium-233, uranium-235, and uranium-238.

Landfill analytes include CLP Metals, VOCs, SVOCs, Pesticides, PCBs, ammonia nitrogen, cyanide, organophosphates, sulfide, total Kjeldhal nitrogen, and major anions (sulfate and chloride).

CLP Contract Laboratory Program
DDT Dichlorodiphenyltrichloroethane
HVOC Halogenated volatile organic compound
IR Installation Restoration
MNA Monitored natural attenuation
MW Monitoring well
PA Preliminary assessment
PAH Polynuclear aromatic hydrocarbon
PCB Polychlorinated biphenyls
SVOC Semivolatile organic compound
TDS Total dissolved solids
TSS Total suspended solids
VOC Volatile organic compound

TABLE 4-8

POTENTIAL WELLS PROPOSED FOR HYDRAULIC TESTS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

RU	Pumping Well	Observation Wells		
RU-C1	IR28IW902A	IR28MW151A IR28MW128A IR28MW173B	IR28IW903A IR28MW916A IR28MW918A	IR28MW921A IR28MW930A
RU-C2	IR58MW31A	IR28MW287A IR28MW397A IR28MW909A	IR28MW910A IR28MW913A IR28MW914A	IR58MW26A IR58MW33B
RU-C4/ C7	IR28MW937F	IR28MW275F IR28MW310F IR28MW311A	IR28MW341F IR28MW393F IR28MW402F	IR28MW932F IR28MW936F
RU-C5	IR06MW44A	IR06MW41A IR25MW11A IR25MW15A1 IR25MW15A2 IR25MW19A	IR25MW22A IR25MW37A IR25MW39A IR25MW40A IR25MW41A	IR25MW42B IR25MW900B IR25MW903B

Notes: The final selection of observation wells will depend on field inspections.

IR Installation Restoration
IW Injection well
MW Monitoring well
RU Remedial unit

TABLE 4-9

WELLS PROPOSED FOR TIDAL STUDIES
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

A. TIDAL INFLUENCE STUDY WELLS

IR Site	Monitoring Well[a]			
Parcel C				
IR-28	IR28MW122A IR28MW149A IR28MW200A IR28MW271A IR28MW298A PA28MW50A	IR28MW124A IR28MW151A IR28MW268A IR28MW272A IR28MW331A	IR28MW125A IR28MW170A IR28MW269A IR28MW293A IR28MW340A	IR28MW126A IR28MW171A IR28MW270A IR28MW297A IR28MW394A
IR-29	IR29MW84A			
IR-50	PA50MW03A			
IR-64	IR64MW05A			
Parcel D				
IR-22	IR22MW07A IR22MW20A	IR22MW08A	IR22MW15A	IR22MW16A
IR-35	IR35MW01A			
Parcel E				
IR-01	IR01MWI-3 IR01MW48A	IR01MW43A IR01MW44A	IR01MWI-7	IR01MWI-8
IR-02	IR02MW147A IR02MW126A IR02MW206A1 IR02MWB-1	IR02MW146A IR02MW149A IR02MW206A2 IR02MWB-2	IR02MW141A IR02MW175A IR02MW209A IR02MWB-3	IR02MW183A IR02MW179A IR02MW300A
IR-03	IR03MW218A1 IR03MW228B IR03MW224A	IR03MW218A2 IR03MW342A IR03MW173A	IR03MW218A3 IR03MW370A IR03MWO-3	IR03MW226A IR03MW371A

TABLE 4-9 (Continued)

WELLS PROPOSED FOR TIDAL STUDIES
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

B. TIDAL MIXING STUDY WELLS

IR Site	Monitoring Well[a]			
Parcel C				
IR-28	IR28MW122A IR28MW268A IR28MW271A	IR28MW124A IR28MW269A IR28MW293A	IR28MW125A IR28MW270A IR28MW297A	IR28MW126A IR28MW171A IR28MW272A
IR-50	PA50MW03A			
Parcel D				
IR-22	IR22MW07A	IR22MW16A		
Parcel E				
IR-01	IR01MWI-7	IR01MWI-8	IR01MW48A	IR01MW44A
IR-02	IR02MW126A IR02MW206A1 IR02MWB-1	IR02MW149A IR02MW206A2 IR02MWB-2	IR02MW175A IR02MW209A IR02MWB-3	IR02MW179A IR02MW300A
IR-03	IR03MW218A1 IR03MW228B IR03MWO-3	IR03MW218A2 IR03MW342A	IR03MW218A3 IR03MW370A	IR03MW226A IR03MW371A

Notes:

a Monitoring wells represent proposed sampling locations. Specific wells may be modified based on further evaluation of existing wells, newly installed wells, and hydrogeologic information.

IR Installation Restoration
MW Monitoring well

TABLE 8-1

SCHEDULE
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Event	Beginning Date	Ending Date
Phase III (Parcels C, D, and E)		
Prepare Phase III FSP/QAPP Addendum – Parcels C, D, and E	December 7, 2001	January 18, 2001
Submit Phase III FSP/QAPP Addendum – Parcels C, D, and E	February 5, 2002	February 5, 2002
BCT Review Period	February 5, 2002	March 5, 2002
BCT Phase III Comment Meeting (tentative)	March 5, 2002	March 5, 2002
Submit Revised Phase III FSP/QAPP Addendum – Parcels C, D, and E	March 26, 2002	March 26, 2002
Parcel C		
Phase III Sampling	March 26, 2002	April 29, 2002
Lab Analysis/Data Management and Review	April 30, 2002	July 22, 2002
Submit Phase III Information Package to BCT	July 22, 2002	July 22, 2002
BCT Review Period	July 22, 2002	August 22, 2002
BCT Comments Due	August 22, 2002	August 22, 2002
Phase III Information Analysis Meeting (tentative)	August 30, 2002	August 30, 2002
Parcel E		
Phase III Sampling – Round 1	March 26, 2002	May 6, 2002
Phase III Sampling – Round 2	June 26, 2002	August 1, 2002
Laboratory Analysis and Data Management and Review	August 1, 2002	November 21, 2002
Submit Phase III Information Package to BCT[a]	November 21, 2002	November 21, 2002
BCT Review Period	November 21, 2002	December 23, 2002
BCT Comments Due	December 23, 2002	December 23, 2002
Phase III Information Analysis Meeting (tentative)	December 30, 2002	December 30, 2002
Radiological		
Phase III Sampling – Round 1	March 26, 2002	April 9, 2002
Phase III Sampling – Round 2	June 26, 2002	July 9, 2002
Laboratory Analysis and Data Management and Review	July 10, 2002	November 4, 2002
Submit Phase III Information Package to BCT	November 4, 2002	November 4, 2002
BCT Review Period	November 4, 2002	December 4, 2002
BCT Comments Due	December 4, 2002	December 4, 2002
Phase III Information Analysis Meeting (tentative)	December 12, 2002	December 12, 2002

Notes:

a Information package may be replaced by presentation in revised Parcel E remedial investigation report

BCT Base Realignment and Closure Cleanup Team
FSP Field sampling plan
QAPP Quality assurance project plan

APPENDIX A

FINAL FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(dated July 31, 2000, provided on CD-ROM only)

Comprehensive Long-Term Environmental Action Navy (CLEAN II)

Contract # N62474-94-D-7609 · Contract Task Orders 0005 and 0011

Field Sampling Plan and Quality Assurance Project Plan Phase I Groundwater Data Gaps Investigation

Hunters Point Shipyard
San Francisco, California

FINAL

Prepared by:

Tetra Tech EM Inc.

July 31, 2000

Department of the Navy • Southwest Division

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Orders 005 and 011

Prepared for

DEPARTMENT OF THE NAVY
David DeMars
Lead Remedial Project Manager
Southwest Division
Naval Facilities Engineering Command
San Diego, California

FINAL
FIELD SAMPLING PLAN
FOR PHASE I GROUNDWATER DATA GAPS INVESTIGATION

HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

DS.0011.14744

July 31, 2000

Prepared by

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Doug Bielskis, Project Manager

FINAL
FIELD SAMPLING PLAN
FOR
PHASE I GROUNDWATER DATA GAPS INVESTIGATION

HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

Prepared for:

DEPARTMENT OF THE NAVY

REVIEW AND APPROVALS

TtEMI Project Manager:	Doug Bielskis TtEMI San Francisco	Date: 7/21/00
TtEMI Program Quality Assurance Manager:	Gregory Swanson TtEMI San Diego	Date: 7.17.00
Navy Lead Remedial Project Manager:	David DeMars	Date: 7/25/00
Navy Quality Assurance Officer:	Narciso Ancog	Date: 7/25/00

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ABBREVIATIONS AND ACRONYMS

API	American Petroleum Institute
ARCH	Air rotary casing hammer
ASTM	American Society for Testing and Materials
BCT	Base Realignment and Closure Cleanup Team
BRAC	Base Realignment and Closure
CLEAN	Comprehensive Long-term Environmental Action Navy Contract
CLP	Contract Laboratory Program
CTO	Contract task order
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
Fe2+	Iron (II)
Fe3+	Iron (III)
FID	Flame ionization detector
FS	Feasibility study
FSP	Field sampling plan
GDGI	Groundwater data gaps investigation
HCl	Hydrochloric acid
HPS	Hunters Point Shipyard
HSP	Health and safety plan
ID	Identification
IDW	Investigation-derived waste
IT Corp.	International Technology Corporation
MNA	Monitored natural attenuation
Navy	U.S. Department of the Navy
PCB	Polychlorinated biphenyl
PID	Photoionization detector
PPE	Personal protective equipment
PRC	PRC Environmental Management, Inc.
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
RI	Remedial investigation
RU	Remedial unit

ABBREVIATIONS AND ACRONYMS (Continued)

SAP	Sampling and analysis plan
SOP	Standard operating procedure
SOW	Scope of work
SVOC	Semivolatile organic compound
SWDIV	Naval Facilities Engineering Command, Southwest Division
TDS	Total dissolved solids
TIZ	Tidally influenced zone
TPH-e	TPH-extractables
TPH-p	TPH-purgeables
TtEMI	Tetra Tech EM Inc.
VOC	Volatile organic compound

1.0 INTRODUCTION

Tetra Tech EM Inc. (TtEMI) received contract task orders (CTO) 005 and 011 under Comprehensive Long-term Environmental Action Navy Contract No. N62474-94-D-7609 (CLEAN II) from the Department of the Navy (Navy), Naval Facilities Engineering Command, Southwest Division (SWDIV) to conduct a remedial investigation (RI) through record-of-decision activities at Parcels D and E (CTO 005) and Parcels B and C (CTO 011) at Hunters Point Shipyard (HPS) in San Francisco, California. TtEMI received subsequent modifications to CTOs 005 and 011 to evaluate groundwater data gaps. Development of the scope of work (SOW) for the groundwater data gaps investigation (GDGI) is based on the input from the HPS Base Realignment and Closure (BRAC) Cleanup Team (BCT), provided during a series of working meetings conducted in February and March 2000 (SWDIV 2000a, 2000b, 2000c, 2000d). Minutes from these working meetings and data summary tables used during the meetings are included as Appendix A of this FSP. The SOW is set forth in detail in this field sampling plan (FSP).

This FSP has been developed to provide specific details about the methods to be used for sample collection, the location and number of samples to be collected, field quality control (QC) procedures, sampling and handling procedures, and shipping. A quality assurance project plan (QAPP) has also been developed to supplement this document. The QAPP fully describes the project data quality objectives (DQO), which have been developed through the seven-step DQO process (U.S. Environmental Protection Agency [EPA] 1994), according to EPA guidance for preparation of QAPPs (EPA 1998). This FSP, along with the accompanying QAPP, make up the sampling and analysis plan (SAP); field crews are expected to have both the QAPP and the FSP on hand at all times, and both documents are included in the same binder for easy reference. A summary of the site background and results of previous investigations is presented in the accompanying QAPP. A more detailed discussion of background and analysis of site information is presented in the Parcels B, C, D, and E RI reports (PRC Environmental Management, Inc. [PRC] 1996a, 1997a, 1996b, and 1997b, respectively) and the feasibility study (FS) reports (PRC 1996c; TtEMI 1998a; PRC 1997c; and TtEMI 1998b, respectively). Data collection and measurement activities detailed in this FSP will be conducted in accordance with TtEMI's "CLEAN II Program Health and Safety Plan (HSP), Revision I" (PRC 1995) and the basewide HSP (PRC 1996d).

The final FSP incorporates revisions made based on regulatory agency comments on the draft version of the FSP dated June 1, 2000. Table 1-1 summarizes these modifications. The Navy's responses to the regulatory agency comments are included as Appendix B of this FSP.

Section 2.0 of this FSP describes the purpose and objectives of this investigation. Section 3.0 provides information about the site location and background. Section 4.0 provides specific details about proposed field methods and field procedures. Section 5.0 presents the procedures to be used for collection and handling of field quality assurance (QA) and QC samples. Section 6.0 provides procedures for sample handling and shipment of samples and chain of custody. Section 7.0 outlines the health and safety concerns and requirements for this investigation and provides references to the basewide HSP. Section 8.0 presents the schedule for the Phase I GDGI. Section 9.0 summarizes the reporting of the Phase I GDGI results. Section 10.0 lists all references cited in this document. Tables, figures, and appendices are presented after the text and references.

2.0 PURPOSE AND OBJECTIVE

The purpose and objectives of this investigation, as well as the chronology of events leading to the Phase I GDGI, are more fully described in the accompanying QAPP. The overall project objective is resolve the following data gaps: (1) most monitoring wells throughout HPS have not been sampled in more than 4 years, and their conditions are unknown, (2) the most current basewide A-aquifer potentiometric surface map was generated more than 4 years ago and may not reflect current groundwater flow conditions, (3) the extent of contamination in the B-aquifer and its relationship to the A-aquifer at Parcels C and D (and potentially at a part of Parcel B) have not been evaluated because chemical and hydrogeologic data are insufficient to support an evaluation, and (4) existing A-aquifer and bedrock water-bearing zone ecological and human health remedial units (RU) at Parcels C and D were developed on the basis of chemical data collected more than 4 years ago.

The specific purpose of this FSP is to detail the four discrete tasks that have been or will be performed under the Phase I GDGI to address the data gaps listed above: (1) assess the condition of all existing wells (completed), (2) measure basewide water levels to determine the potentiometric surface at existing A- and B-aquifer wells (completed), (3) perform additional characterization of the B-aquifer in Parcels C and D by sampling existing and newly installed wells for hydrogeologic (including yield, permeability, horizontal gradient, and vertical gradient) and chemical parameters, and (4) resample A-aquifer wells in Parcels C and D for chemical parameters to characterize the extent of contamination. The conditions of all existing wells at HPS were evaluated in April 2000; results have been incorporated into this FSP. Water levels were measured at 189 A-aquifer wells and 19 B-aquifer wells throughout HPS on July 12, 2000; preliminary results will be available by August 16, 2000. In addition, task 3 will involve water level measurements at 20 newly installed B-aquifer wells and the 19 existing B-aquifer wells at HPS. Tasks 3 and 4 will include the collection of total dissolved solids (TDS) data at all wells sampled during the Phase I GDGI. The TDS data will aid in refining and/or confirming the areas that meet the federal and state drinking water criteria of 10,000 and 3,000 milligrams per liter (mg/L), respectively.

The Phase I GDGI is the initial investigation phase intended to resolve the data gaps previously discussed. The second phase of the GDGI will involve a second round of sampling during the "dry season," in early Fall 2000. The second sampling event will incorporate the data gathered during the Phase I GDGI; the number of monitoring wells may increase or decrease, as deemed appropriate following an evaluation of the initial data. In addition, subsequent investigation phases may include further investigation at Parcels B, C, D, and E based on the results of the previous GDGI phases. This FSP and the accompanying QAPP will be amended to be applicable to subsequent phases of the GDGI.

3.0 SITE LOCATION AND BACKGROUND

The following sections provide brief descriptions of the site location and background. A more detailed discussion of the environmental setting of the site is provided in the accompanying QAPP.

3.1 FACILITY LOCATION

HPS is located in southeast San Francisco on a promontory that extends east into San Francisco Bay (Figure 3-1). The HPS facility consists of five contiguous geographic parcels (A through E) making up approximately 493 acres, and a sixth parcel, the offshore area (Parcel F), which is approximately 443 acres in size. Parcel B occupies approximately 63 acres of shoreline and lowland coast in the northeastern portion of HPS. Parcel C consists of approximately 79 acres of shoreline and lowland coast along the east-central portion of HPS. Parcel D occupies approximately 128 acres of southeast-central shoreline and lowland coast. Parcel E consists of approximately 135 acres of shoreline and lowland coast in the southern portion of HPS.

3.2 FACILITY BACKGROUND

HPS operated as a commercial dry dock facility from 1869 until December 29, 1939, when the Navy purchased the property. From 1945 until 1974, the Navy built ships and modified, maintained, and repaired submarines at HPS. In 1974, the Navy ceased shipyard operations at HPS, placed the facility in industrial reserve, and transferred control of the property to its Office of the Supervisor of Shipbuilding, Conversion, and Repair in San Francisco. From May 1976 to June 1986, Triple A Machine Shop leased most of HPS from the Navy and operated a commercial ship repair facility.

Parcel B has been used primarily to house office and commercial buildings and warehouses. The Navy also conducted industrial activities at Parcel B, such as storage and distribution of fuel, sandblasting and painting, machining, acid mixing, and metal fabrication. Parcel C, the oldest portion of the shipyard, was used since the late 1800s almost exclusively for industrial purposes. Parcel D was used primarily for shipping and ship repair and to house offices and commercial buildings. Parcel E was a mixed-use and industrial area that supported shipping and ship repair activities at HPS. The shoreline areas were used to store construction and industrial materials, as well as to dispose of industrial waste and construction debris. In 1991, HPS was designated for closure under the federal BRAC program, with the intent of transferring the property and facilities to neighboring communities as expeditiously as possible and with minimal adverse effect on the local economy.

Further background information about each site is presented in Section A3 of the accompanying QAPP, as well as in the RI reports for Parcels B, C, D, and E (PRC 1996a, 1997a, 1996b, and 1997b, respectively) and in the FS reports for those parcels (PRC 1996c; TtEMI 1998a; PRC 1997c; and TtEMI 1998b, respectively).

4.0 FIELD METHODS AND PROCEDURES

The following sections provide details about procedures and methods to be used in the field. Activities detailed in the following subsections include monitoring well inspections (Section 4.1), water level measurement (Section 4.2), groundwater sampling (Section 4.3), well installation (Section 4.4), well development (Section 4.5), field equipment calibration (Section 4.6), decontamination (Section 4.7), and investigation-derived waste (IDW) management (Section 4.8).

4.1 MONITORING WELL INSPECTIONS

The Navy conducted a basewide monitoring well inspection survey in April 2000. During the inspections, the Navy completed light maintenance of monitoring wells, including replacement of malfunctioning well caps and locks, replacement of missing lid bolts, and renewal of the water level measurement mark or notch and external well identification information. The Navy recorded all well inspection information and noted recommended repairs, when necessary, on monitoring well inspection forms (Appendix 1, QAPP). Results of the well inspection survey are presented in Table 4-1 of this FSP.

Monitoring well locations are shown on Figure 4-1. At each monitoring well, inspections evaluated the following:

- Condition of external well identification information
- Condition of the concrete pad and surrounding area
- Condition of the well vault, lid, rubber seal, and lid bolts or well stickup and riser standpipe
- Presence of standing water (precipitation or other) in the vault
- Location of the vault in relation to the surrounding ground surface (for example, whether the surrounding grade encourages drainage toward the well vault)
- Condition of the internal well identification tag
- Condition of the well lock and well cap
- Condition of the water level measuring mark or notch
- Condition of the well casing

Water level and total depth measurements were also collected at each monitoring well. Based on the results of the well inspection survey, the Navy will perform basic maintenance and repair of wells. Repairs may include replacement of well vaults, well guard posts, and concrete pads. Wells will be repaired in accordance with the provisions of California Water Well Standards.

4.2 WATER LEVEL MEASUREMENT

Water levels were measured at 187 A-aquifer wells and 18 B-aquifer wells basewide, as listed in Table 4-2 and shown on Figure 4-1, to assess horizontal groundwater gradients. All water levels were measured within a 4-hour period of relatively low tidal fluctuation on July 12, 2000. To collect groundwater levels at times when tidal fluctuation is minimal, the following procedure was followed:

- Approximately 14 persons each measured water levels in approximately 15 different wells over a period not exceeding 4 hours. This scheme allowed an average of approximately 15 minutes for each well measurement, including time of travel between wells.
- Before the measurement period began, all well covers were unlocked and unfastened to allow speedy access to the well during the measurement period.
- The measurement period fell during a period of relatively low tidal fluctuation in San Francisco Bay. In particular, the tidal fluctuation during the July 12 measurement period was less than two feet.
- Measurement of groundwater levels began 1 hour before the high tide and was completed in less than 4 hours (that is, no later than 3 hours after the high tide).

- During the measurement period, groundwater levels generally were measured first in wells nearest the shore (that is, the locations expected to display the highest tidal efficiency). Water level measurement proceeded to wells farther away from the shore (that is, the locations expected to display relatively lower tidal efficiencies), with the wells farthest from the shore measured last. This order of monitoring wells minimized the effects of tidal fluctuation on the water levels because (1) wells that display the greatest degree of tidal fluctuation were measured during a period when the rate of water level change as a result of tidal fluctuation was relatively low and (2) wells that display less tidal fluctuation were measured during a period when the rate of water level change due to tidal fluctuation was relatively higher (but not as significant as for wells closer to the shoreline).

In addition, water level measurements will be collected upon completion and development of 20 new A- and B-aquifer well pairs, as discussed in Section 4.4 of this FSP; B-aquifer water level measurements will also include measurements at the 19 existing B-aquifer wells at HPS. Salinity measurements at the A- and B-aquifer well pairs will also be collected to determine vertical gradient. Water level measurements will be collected as set forth in TtEMI standard operating procedure (SOP) No. 14, "Revision No. 0, Static Water Level, Total Well Depth, and Immiscible Layer Measurement" (presented in Appendix C), as amended in this section. Initial measurements of organic vapor and dissolved oxygen will be taken with a photoionization detector (PID) or flame ionization detector (FID) and a down-the-well probe, respectively, as discussed in Section 4.3.2 of this FSP. Accordingly, respiratory protection equipment will be immediately available to each team but not necessarily worn while approaching each well. The field team will record all water level measurements in field logbooks or well inspection forms (Appendix 1, QAPP).

Since several years have passed since the initial well survey, top of casing elevations at 24 select wells (as shown in Table 4-3 and on Figure 4-1) will be measured to confirm previous survey measurements. In addition, top of casing and/or ground surface elevations will be measured at approximately 65 wells where survey data are incomplete, as detailed in Table 4-2 and on Figure 4-1.

4.3 GROUNDWATER SAMPLING

The following sections provide details about (1) sample locations, (2) initial measurement of organic vapors and dissolved oxygen, (3) sampling methods, and (4) sample analysis. Additional details about chemical analysis of groundwater and QC samples are provided in the accompanying QAPP.

4.3.1 Sample Locations

Groundwater samples will be collected from monitoring wells identified in Table 4-4 and on Figures 4-2 through 4-5, in accordance with the schedule presented in Section 8.0. The specific rationale for the sampling locations in Parcels C and D is presented in Tables 4-5 and 4-6, respectively. Monitoring wells within the tidally influenced zone (TIZ) (identified on Figure 4-1) will be sampled within a 4-hour period of relatively low tidal fluctuation to provide the optimum comparison with results from other wells located outside of the TIZ. Well construction logs for the wells to be sampled for the Phase I GDGI are included in Appendix D of this FSP.

4.3.2 Initial Measurement of Organic Vapor and Dissolved Oxygen

Before each well is purged, organic vapor and dissolved oxygen will be measured with a PID or FID and a down-the-well probe, respectively. Immediately after the well cap has been removed, PID or FID detector measurements will be collected from the headspace at the top of the inner casing. Dissolved oxygen will be measured at three intervals within the water column: the top of the screened interval, the middle of the screened interval, and the bottom of the screened interval. The three discrete depth measurements of dissolved oxygen will quantify vertical variations for the evaluation of natural attenuation and for plume characterization. Dissolved oxygen data will be collected with a calibrated dissolved oxygen meter. Initial organic vapor and dissolved oxygen data will be recorded on monitoring well sampling sheets (Appendix 1, QAPP).

4.3.3 Sampling Methods

Groundwater monitoring wells will be sampled in accordance with either TtEMI SOP No. 10, "Revision No. 3, Groundwater Sampling," or No. 15, "Revision No. 0, Groundwater Sample Collection Using Micropurge Technology" (presented in Appendix C), as amended below. Micropurge sampling techniques, consistent with TtEMI SOP No. 15, will be the preferred sampling procedure; however, standard well purging and sampling techniques in accordance with TtEMI SOP No. 10 may be used as field conditions warrant. If standard well purging and sampling techniques are used, a new, certified-clean disposable Teflon bailer will be used to purge and sample groundwater from each monitoring well containing a small water column. To efficiently extract purge water from monitoring wells that contain large water columns (for example, 6-inch-diameter wells), purge water may be extracted with a bladder pump or a submersible (nonoil-bearing) pump, then sampled with a clean, reusable stainless steel bailer or a new, certified-clean disposable Teflon bailer. Purge water will be managed as described in Section 4.8. After three well volumes have been purged from the well or after parameter readings stabilize to within 10 percent of the previous measurement for each parameter (pH, temperature, and specific conductance) identified in the SOP, in addition to dissolved oxygen, oxidation-reduction potential, and turbidity, the well will be considered ready for sampling. If the stabilization parameters do not fall within the specified ranges after three well volumes, the well will be purged until the parameters stabilize or until four well volumes have been purged. If, during well purging, the well runs dry before the specified amount of purge water has been withdrawn, the well will be allowed to recharge; after it has recharged to a minimum of 80 percent, one set of parameters will be measured, and the well will be sampled. Sample collection information will be recorded on monitoring well sampling forms, as shown in Appendix 1 of the accompanying QAPP.

4.3.4 Sample Analysis

As indicated in Table 4-4, samples from each well will be analyzed for the following site-specific analytes of concern: low-level EPA Contract Laboratory Program (CLP) volatile organic compounds (VOC); low-level CLP semivolatile organic compounds (SVOC); low-level CLP pesticides and polychlorinated biphenyls (PCB); CLP dissolved metals; total petroleum hydrocarbons-extractable (TPH-e); total petroleum hydrocarbons-purgeable (TPH-p); hexavalent chromium; and monitored natural attenuation (MNA) parameters. MNA parameters include methane, ethane, ethene, reduced metals iron (II) (Fe^{2+}) and iron (III) (Fe^{3+}), nitrate, nitrite, sulfate, dissolved oxygen, oxidation-reduction potential, chloride, carbonate, calcium, magnesium, sodium, potassium, salinity, and TDS. Table 2-1 in Appendix 2 of the accompanying QAPP identifies the sample methods, containers, preservation, and holding times for all constituents to be analyzed for in groundwater samples. Section 6.1 of this FSP describes the sample identification (ID) system.

Sample bottles will be filled in accordance with the provisions of TtEMI SOP No. 10, Revision 3, "Groundwater Sampling," as amended below. The following bullets summarize the order of sample collection:

- First, collect samples for analysis for CLP VOCs, methane, ethane, ethene, and TPH-p in containers, as listed in Table 2-1, Appendix 2 of the accompanying QAPP. Samples for those parameters must be collected with zero headspace in the vial. After sealing the sample to be analyzed, invert the vial and inspect for air bubbles. If air bubbles are present, the sample must be discarded and the groundwater resampled.

- In cases in which the groundwater reacts with the hydrochloric acid (HCl) preservative in the containers and prevents collection of a preserved sample without bubbles, it is acceptable to collect the VOC, methane, ethane, ethene, and TPH-p samples in unpreserved sample vials. Record on the field sheets and chain-of-custody records samples from the wells that reacted with HCl. Note that the groundwater sample reacted with the HCl preservative and that an unpreserved sample was collected (since the holding time for the sample will be reduced). Alternatively, solid sodium sulfate ($NaHSO_4$) may be used as a preservative contingent upon approval by the project chemist.

- Second, collect the samples to be analyzed for other organics (SVOCs, TPH-e, and pesticides, and PCBs). Fill amber bottles to the neck of the bottle.

- Third, collect the samples to be analyzed for inorganics (metals, hexavalent chromium, and MNA parameters). Samples collected for analysis for dissolved metals will be filtered in the field using disposable, high-capacity 0.45-micron filters. A Fisher Scientific filter (part number 12020) or equivalent will be used. Each sample to be analyzed for dissolved metals will be pumped through the filter using a peristaltic pump and Tygon tubing. New tubing and filters will be used for all samples to be analyzed for dissolved metals. Fill each preserved polyethylene sample bottle to the neck.

Immediately following sample collection, samples designated for off-site laboratory analysis will be transferred to a cooler maintained at 4 °C.

4.4 WELL INSTALLATION

A-aquifer and B-aquifer monitoring wells will be drilled, installed, and developed in the locations shown on Figures 4-4 and 4-5. Refer to Tables 4-5 and 4-6 of this FSP, and Section A1.4.7 of the accompanying QAPP for specific rationale for placement of the A-aquifer and B-aquifer wells. Table 4-7 summarizes the anticipated depths, casing diameter, and screen intervals for the A- and B-aquifer monitoring wells to be installed; however, the specifications for each well may be modified to accommodate site-specific conditions. In general, the top of the screen interval for A-aquifer wells will extend at least one foot above the highest seasonal groundwater elevation. The screen interval (typically 10 feet in length) for B-aquifer wells will be placed at the bottom of the B-aquifer (that is, directly overlying bedrock). All well drilling activities will be supervised by a field geologist and performed by a well drilling contractor licensed by the state of California that will use mud rotary or air rotary casing hammer (ARCH) methods. ARCH drilling methods, conducted in accordance with International Technology Corporation (IT Corp.) SOP 14.3, "Air Rotary Drilling" (Appendix E), will be the preferred drilling method; however, mud rotary methods, according to the provisions of IT Corp. SOP 14.2, "Mud Rotary Drilling" (Appendix E), may be used as field conditions warrant.

During well drilling activities, undisturbed soil samples will be collected using a modified California sampler at 5-foot intervals within the A-aquifer and Bay Mud sediments and at 10-foot intervals within the B-aquifer sediments. A field geologist will log the soil samples and prepare a lithologic log using American Society for Testing and Materials (ASTM) Method D2488-93 (ASTM 1993a). All lithologic logging will be conducted under the supervision of a California Registered Geologist. In addition, a single soil sample will be collected from each new B-aquifer well at a depth within the well screen interval. The soil sample will be analyzed for effective porosity and hydraulic conductivity by American

Petroleum Institute (API) Method RP40 (API 1998) and ASTM Method D5084 (ASTM 1993b), respectively.

The screen and well casing (fitted with sediment trap and end cap) will be suspended in the center of the borehole with the aid of well centralizers so that the screen interval occurs at the well design depth. The sand pack material for the monitoring wells will be placed through the drive casing to an elevation approximately 3 feet above the top of the well screen. The drive casing will be removed slowly from the borehole as the sand pack is placed around the screen using a tremmie pipe. During installation, the drive casing will not be pulled higher than 2 feet below the top of the sand pack. During placement of the sand pack, frequent measurement of the top of the sand pack will be made to ensure that the bottom of the drive casing is not above the top of the sand pack. Before the bentonite seal is placed, the filter pack will be carefully surged and then remeasured to ensure correct placement of the sand pack. If necessary, additional sand pack material will be added to ensure that the position of the sand pack is correct.

A 3- to 5-foot-thick bentonite seal will be placed above the top of the sand pack. Bentonite pellets, chips, slurry, granular bentonite or fine sand will be used, as determined by the geologist. After the bentonite seal has been placed, the remainder of the borehole annulus, up to 2 feet below grade surface, will be backfilled with a grout mix using a tremmie pipe. Following grouting, after a minimum of 24 hours, a flush-mounted, traffic-rated concrete box with a bolted steel cover will be installed.

During well drilling activities using ARCH methods, the drive casing will temporarily isolate the A- and B-aquifers, and maintain the integrity of the Bay Mud aquitard. If mud rotary methods are used, the density of drilling fluid and the mud cake created on the sidewalls of the borehole will prevent intrusion of groundwater in the borehole annulus. This density differential and the presence of the mud cake prevents intrusion of aquifer water into the borehole during pilot boring drilling and geophysical logging activities, and maintains the integrity of the Bay Mud aquitard.

Additional well installation procedures are specified in remedial action work plan (IT Corp. 1999) and in IT Corp. SOP 8.1, “Monitoring Well Installation” (Appendix E).

4.5 WELL DEVELOPMENT

Following construction, each well will be developed to maximize yield and minimize turbidity of the water. Wells will be developed using a bailer and a vented surge block and submersible pump, according to the provisions of IT Corp. SOP 8.2, “Monitoring Well Development” (Appendix E). Well development will not commence until the cement-bentonite grout has been in place and allowed to set for at least 24 hours.

Monitoring wells will be developed by alternately surging with a vented surge block and bailing. The well will be considered adequately developed when the water produced is sand-free and clear and has a reading of less than 10 nephelometric turbidity units, and when the pH, temperature, and specific conductance have stabilized to within ±5 percent. Well development logs will be used to provide a preliminary assessment of whether the new wells will meet the federal or state yield criteria of 150 and 200 gallons per day, respectively. If the results indicate that the wells will not meet the yield criteria, a more detailed assessment will be conducted as part of subsequent phases of the GDGI. New wells will be sampled a minimum of 24 hours after development.

4.6 FIELD CALIBRATION EQUIPMENT

As appropriate, field measurement equipment will be calibrated daily before use, or as detailed in the manufacturer's or vendor's operating manual for each device. Calibration data will be recorded in field logbooks or on calibration forms (Appendix 1, QAPP).

4.7 DECONTAMINATION

Before it is used, all sampling and drilling equipment will be decontaminated by steam cleaning or by washing with a nonphosphate detergent, such as Liquinox or an equivalent, followed by a tap water rinse, a distilled water rinse, and a final rinse with laboratory-supplied deionized water. The following sections provide brief descriptions of decontamination procedures to be used in the field.

4.7.1 Well Installation and Development

Before drilling, the drilling rig and all downhole equipment will be decontaminated according to the provisions of IT Corp. SOP 6.2, "Drilling and Heavy Equipment Decontamination" (Appendix E). Before installation, all well materials, exclusive of sand pack, bentonite seal, and grout, will be decontaminated according to the provisions of IT Corp. SOP 6.1, "Sampling Equipment and Well Material Decontamination" (Appendix E).

4.7.2 Groundwater Sampling

Groundwater sampling equipment will be decontaminated in accordance with procedures specified in TtEMI SOP No. 002, Revision No. 2, "General Equipment Decontamination" (Appendix C), as applicable. Should floating product be encountered during sampling, all sampling equipment used will be decontaminated by both steam cleaning and detergent washing, as appropriate. The procedure will remove product and minimize the possibility of cross-contamination. Decontamination fluids will be placed in containers and handled in accordance with the procedures set forth in Section 4.8 of this FSP.

4.8 INVESTIGATION-DERIVED WASTE MANAGEMENT

All IDW will be handled according to the procedures outlined in the CLEAN program waste management plan (PRC 1994). All purge water and decontamination fluids will be placed in 55-gallon drums approved by the U.S. Department of Transportation. The purge water from any well that has a history of high levels of contamination will be segregated in 55-gallon drums. Remaining IDW water will be stored in 55-gallon drums or pumped daily into an on-site storage tank. IDW containers will be labeled with information about their contents, the source of their contents, the generation date of the contents, and the Navy point of contact. When field work has been completed, all drums will be moved to an IDW storage area (shown on Figure 4-1). Samples of the IDW will be collected, and the analytical results will be used to select the appropriate method of disposal. IDW will be disposed of in accordance with state and federal regulations. As appropriate, personal protective equipment (PPE) and miscellaneous waste from sampling (for example, paper towels) will be placed in garbage bags, sealed, and disposed of in on-site trash receptacles.

5.0 FIELD QUALITY ASSURANCE AND QUALITY CONTROL SAMPLES

The purpose of QA/QC is to ensure that routine sampling procedures are followed to control the reliability and defensibility of data. QC samples collected in the field will be used to assess the overall quality of the project. Field QC samples consist of field duplicates, equipment rinsates, trip blanks, and source water blanks. During the investigation, QA/QC samples will be collected, according to the procedures presented in Section B6.1 of the accompanying QAPP.

6.0 SAMPLE HANDLING, SHIPMENT, AND CHAIN OF CUSTODY

This section presents the procedures for sample designation and labeling. Standard sample custody procedures will be used to document sample integrity during the collection, transportation, storage, and analysis process. The field team leader is responsible for implementing procedures that will allow tracing of samples from the time of collection to the time of receipt by the laboratory. The laboratory QA coordinator is responsible for establishing a sample control system that will allow tracing of sample custody from receipt by the laboratory to the final disposition of the samples. Section B4 of the accompanying QAPP describes sample handling procedures, sample containerization and preservation, and sample documentation. Documentation and records, including field forms and logbooks, are discussed in Section A4.4 of the accompanying QAPP, and blank field forms are presented in Appendix 1 of the accompanying QAPP. Roles and responsibilities are discussed in Section A2 of the accompanying QAPP.

6.1 SAMPLE IDENTIFICATION AND LABELING

The HPS database manager will assign specific identifiers (sample IDs) to groundwater sampling activities. The sample type and ID will be recorded on the extended chain-of-custody form and on well sampling sheets. The sample IDs for all sampling locations will be arranged in the following manner:

0011A222

where:

00	=	Last two digits of the year
11	=	Week of the year
A	=	Sampler's initial
222	=	Sequential sample ID number for sampler "A"

The sample ID will be entered on the sample labels, field forms, extended chain-of-custody forms (yellow copy), and any other records that document sampling activities. To minimize possible bias by the laboratory when analyzing samples, the location IDs (listed in Table 4-4 of this FSP) will not be entered on the original copy of the chain-of-custody form (white copy) that travels with the samples to the laboratory. A label will be affixed to each container when the sample is collected. The label will be completed with the following information, written in indelible ink:

- Sample identification number
- Date and time of sample collection
- Project name
- Sample collector's initials

- Preservative used (if applicable)
- Filtering (if applicable)
- Analysis required

After the label has been completed, it will be covered with clear plastic tape wrapped around the container to prevent tampering and damage.

6.2 SAMPLE CONTAINERIZATION, PRESERVATION, AND HOLDING TIME

Each water sample will be collected in or decanted to an appropriate container provided by the laboratory. Samples will be properly documented, as described in Section 6.3, at the time of collection. Some of the parameters to be measured in the water samples are not chemically stable under certain conditions and, therefore, sample preservation will be required. Containers that have been preserved by the laboratory will be labeled as such. Samples will be analyzed by the laboratory within the holding times specified by EPA for each analyte. Table 2-1 in Appendix 2 of the accompanying QAPP presents information regarding the sample containers, method of preservation, analytical method, and holding time for each analytical method.

6.3 DOCUMENTATION

During field sampling, several forms of documentation will be maintained, including bound field logbooks, daily QC reports, chain-of-custody forms, and groundwater sampling data sheets. Such documentation is necessary to enter information about new samples into the database and to provide an accurate record of sampling events and field observations. Documentation and records, including field forms and bound logbooks, are discussed in Section A4.4 of the accompanying QAPP. Blank field forms are presented in Appendix 1 of the accompanying QAPP.

7.0 HEALTH AND SAFETY

A basewide HSP (PRC 1996d) was prepared for activities at HPS. The basewide HSP provides information about the physical, biological, and chemical hazards associated with the various field activities to be conducted during the investigation. The basewide HSP also provides a detailed discussion of anticipated health and safety concerns related to the investigation.

8.0 SCHEDULE

The schedule for the HPS Phase I GDGI is provided in Table 8-1. The schedule relies on a number of assumptions that, when fully defined, may result in changes in or updates of the proposed schedule. Critical assumptions include those related to document review times.

9.0 REPORTING

Water level and water quality data gathered from the Phase I GDGI will be presented to the BCT in information packages similar to the packages provided for the working meetings in February and March 2000. The information package will include contour maps of TDS and water level measurement data gathered during the Phase I GDGI, and historical TDS and water level data for comparison purposes. The schedule for submittal of the Phase I GDGI information packages is provided in Table 8-1. The BCT's evaluation of the information packages will be incorporated into the revised FSs for Parcels C and D. In addition, following the completion of Phase II of the GDGI, the groundwater areas proposed for evaluation in the revised FSs will be specified in a beneficial use letter (submittal date identified in Table 8-1).

10.0 REFERENCES

American Petroleum Institute (API). 1998. "Recommended Practices for Core Analysis." Recommended Practice 40.

American Society for Testing and Materials (ASTM). 1993a. "Description and Identification of Soils, Visual-Manual Procedure." Method D2488-93.

ASTM. 1993b. "Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter." Method D 5084-93.

International Technology Corporation (IT Corp.). 1999. "Hunters Point Shipyard (HPS), Parcel B, Remedial Action Work Plan, Revision 9."

PRC Environmental Management, Inc. (PRC). 1994. "CLEAN Program Waste Management Plan for Investigation-Derived Waste." January 31.

PRC. 1995. "CLEAN II Program Health and Safety Plan. Revision I." June 19.

PRC. 1996a. "Draft Final Parcel B Remedial Investigation (RI) Report, HPS, San Francisco, California." June 3.

PRC. 1996b. "Draft Final Parcel D RI Report, HPS, San Francisco, California." October 25.

PRC. 1996c. "Draft Final Parcel B Feasibility Study (FS), HPS, San Francisco, California." November 26.

PRC. 1996d. "Final Basewide Health and Safety Plan, HPS, California." June 6.

PRC. 1997a. "Draft Final Parcel C RI Report, HPS, San Francisco, California." March 13.

PRC. 1997b. "Draft Final Parcel E RI, HPS, San Francisco, California." May 29.

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Southwest Division, Naval Facilities Engineering Command (SWDIV). 2000a. Parcel D Groundwater Evaluation, HPS, Meeting Minutes (Final), February 7, 2000. From Richard Mach, Base Realignment and Closure (BRAC) Environmental Coordinator (BEC), SWDIV. To HPS BRAC Cleanup Team (BCT) and the City of San Francisco. March 31.

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Tetra Tech EM Inc. (TtEMI). 1998a. "Draft Final Parcel C FS, HPS, San Francisco, California." April 6.

TtEMI. 1998b. "Draft Parcel E FS, HPS, San Francisco, California." January 15.

TtEMI. 1999. "Draft Final Parcel B Remedial Design Documents, HPS, San Francisco, California."

U.S. Environmental Protection Agency (EPA). 1994. "Guidance for the Data Quality Objectives Process." Final. EPA QA/G-4. September.

EPA. 1998. "EPA Guidance for Quality Assurance Project Plans." EPA QA/G-5. EPA/600/R-98/018.

TABLES

TABLE 1-1

REVISIONS TO DRAFT FIELD SAMPLING PLAN
PHASE 1 GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Section	Modification
2.0	• Clarified the purpose and objective of the Phase I GDGI • Revised to distinguish the basewide water level measurements to be collected at the A-aquifer and B-aquifer wells • Revised to indicate that the following hydrogeologic parameters will be evaluated at the B-aquifer wells: yield, permeability, horizontal gradient, and vertical gradient • Elaborated on beneficial use analysis referenced in Tables 4-5 and 4-6 • Specified that the existing SAP will be amended to apply to subsequent phases of the GDGI
4.2	• Specified that B-aquifer water level measurement event (including adjacent A-aquifer wells) will be conducted upon completion of the new B-aquifer wells • Revised to include updated number of wells for land survey
4.3.3	• Revised to specify that ORP measurements will be collected during well purging • Revised to state that micropurging techniques (in accordance with TtEMI SOP 15) will be the preferred sampling method; however, standard well purging and sampling techniques (in accordance with TtEMI SOP 10) may be used as field conditions warrant • Added methane, ethane, and ethene into sampling sequence along with VOC and TPH-p sampling
4.4	• Revised to indicate that (1) pilot borings will not be used, (2) ARCH will be the preferred drilling method (however, mud rotary methods may be used as field conditions warrant), (3) soil samples will be collected for lithologic logging at 5-foot intervals (in A-aquifer and Bay Mud) and at 10-foot intervals (in B-aquifer), and (4) a single soil sample within the screen interval at each B-aquifer well will be analyzed for effective porosity and hydraulic conductivity • Revised to specify that A-aquifer well screen intervals will extend at least 1-foot above the highest seasonal groundwater elevation, and B-aquifer well screen intervals will be placed at the bottom of the B-aquifer
4.5	• Revised to indicate that that well development logs for the newly installed B-aquifer wells will be used to provide a preliminary assessment of whether the wells will meet the federal or state yield criteria. If the results indicate that the wells will not meet the yield criteria, a more detailed assessment will be conducted as part of Phase II.

TABLE 1-1 (Continued)

REVISIONS TO DRAFT FIELD SAMPLING PLAN
PHASE 1 GROUNDWATER INVESTIGATION FIELD SAMPLING PLAN
HUNTERS POINT SHIPYARD
(Page 2 of 3)

Section	Modification
9.0	• Moved existing Section 9.0 "REFERENCES" to Section 10.0 and create new Section 9.0 titled "REPORTING" to discuss reporting of Phase I GDGI results, and subsequent incorporation into revised FS
10	• Revised former Section 9.0 (references) to include minutes from working meetings
Figure 4-1	• Updated to include additional wells for water level and survey measurements • Specified location of decontamination and IDW storage area in Parcel E
Figures 4-2, 4-3, 4-4, 4-5	• Revised to indicate that "remedial units shown represent areas with point exceedances that are proposed for further evaluation"
Table 4-1 (draft Table 4-2)	• Revised to include updated results of well condition survey and renamed as Table 4-1
Table 4-2 (draft Table 4-1)	• Revised to include updated number of wells for water level measurement event and renamed as Table 4-2
Table 4-3	• Revised to include updated number of wells for land survey
Table 4-4	• Specified that product samples will be collected at wells IR25MW11A and IR25MW22A (without purging) and analyzed for PCBs • Revised to include VOC analysis to the analysis suite for well IR29WM57A • Revised to include sampling for VOC, TPH, and TDS analysis at new wells IR06MW22A and IR06MW32A • Revised to include salinity measurements at all B-aquifer wells and adjacent A-aquifer wells • Revised to specify collection of at least one equipment rinsate blank per day per parameter • Revised to indicate that a double volume of water will be collected for MS/MSD samples • Added methane, ethane, and ethene to MNA analyte suite • Added Cr VI analysis to Parcel C wells where Cr was identified as an analyte of concern (wells IR28MW125A, IR28MW127A, IR28MW155A, and IR58MW25F)
Table 4-7 (final)	• Created new table specifying typical well casing diameter, well depth, and screen interval length and placement

TABLE 1-1 (Continued)

**REVISIONS TO DRAFT FIELD SAMPLING PLAN
PHASE 1 GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 3 of 3)**

Section	Modification
Table 8-1	• Revised to include submittal dates for beneficial analysis letter and Phase I GDGI information package, and a revised date for Phase I GDGI information analysis meeting • Revised to include specific dates for water level measurement events and other revised field dates • Specified dates for well inspections and repair activities
Appendix A (new)	• Created new appendix to include copies of final meeting minutes from February and March 2000 meetings, and to include data summary tables from the meetings
Appendix B (new)	• Created new appendix to include copies of Navy's response to agency comments

Notes:

ARCH	Air rotary casing hammer
Cr VI	Hexavalent chromium
FS	Feasibility study
GDGI	Groundwater data gaps investigation
IDW	Investigation-derived waste
MNA	Monitored natural attenuation
MS/MSD	Matrix spike/matrix spike duplicate
ORP	Oxidation-reduction potential
PCB	Polychlorinated biphenyl
SOP	Standard operating procedure
TDS	Total dissolved solids
TPH	Total petroleum hydrocarbons
TPH-p	Total petroleum hydrocarbons, purgeable
TtEMI	Tetra Tech EM Inc.
VOC	Volatile organic compound

TABLE 4-1

RESULTS OF WELL CONDITION SURVEY
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

WELLS FOR WHICH ADDITIONAL SURVEY DATA ARE NEEDED			
IR Site	**Monitoring Well**		**Comment**
PARCEL B			
IR-06	IR06MW22A	IR06MW32A	New wells (re-installed for TPH CAP): missing horizontal coordinates, top of casing, surface elevation
IR-24	PA24MW03A		New well (re-installed for TPH CAP): missing horizontal coordinates, top of casing, surface elevation
IR-46	IR46P38AA	IR46P38AB	Missing top of casing, surface elev.
IR-62	IR62MW07A		Missing top of casing
PARCEL C			
IR-25	IR25MW18A IR25MW19A	IR25MW20A IR25MW22A	Missing top of casing, surface elev.
IR-28	IR28MW324A IR28MW325A IR28MW326A IR28MW327A IR28MW328A IR28MW329A IR28MW330A IR28MW331A IR28MW333A IR28MW334A	IR28MW335A IR28MW336A IR28MW337A IR28MW338A IR28MW339A IR28MW340A IR28MW341F IR28MW342F IR28P50AB PA28P02A	Missing top of casing, surface elev.
	PA28P3		Missing horizontal coordinates, top of casing, surface elev.
PARCEL D			
IR-09	IR09P35AA	IR09P35AB	Missing top of casing, surface elev.
IR-44	IR44MW08A		Missing top of casing

TABLE 4-1 (Continued)

RESULTS OF WELL CONDITION SURVEY
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 6)

WELLS FOR WHICH ADDITIONAL SURVEY DATA ARE NEEDED			
IR Site	**Monitoring Well**		**Comment**
PARCEL E			
IR-01	IR01MW366A		Missing top of casing
	IR01P03AA	IR01P03AB	Missing top of casing, surface elev.
	IR01P18AB	IR01P02BB	Missing horizontal coordinates, top of casing, surface elev.
IR-02	IR02P93AA	IR02P97AA	Missing horizontal coordinates, top of casing, surface elev.
IR-15	IR15MW08AA	IR15MW08AB	Missing horizontal coordinates, top of casing, surface elev.
IR-36	IR36MW120B IR36MW121A IR36MW122A IR36MW123B IR36MW125A IR36MW126A	IR36MW127A IR36MW128A IR36MW129B IR36MW137A IR36MW13A	Missing top of casing
IR-72	IR72MW33A		Missing top of casing
IR-73	IR73MW04A		Missing top of casing
IR-74	IR74MW01A		Missing top of casing
IR-75	IR75MW05A		Missing horizontal coordinates, top of casing, surface elev.

Notes:

CAP Corrective action plan
TPH Total petroleum hydrocarbons

TABLE 4-1 (Continued)

RESULTS OF WELL CONDITION SURVEY
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 3 of 6)

WELLS THAT REQUIRE REDEVELOPMENT BEFORE RESAMPLING				
IR Site	**Monitoring Well**			
PARCEL B				
IR-10	IR10MW13A2			
IR-62	UT02MW17A			
PARCEL C				
IR-25	IR06MW45A*			
IR-28	IR28MW309B*			
IR-29	IR29MW58F*	IR29MW84A*		
IR-58	IR58MW25F*			
PARCEL D				
IR-08	IR08MW37A			
IR-34	IR34MW35A			
PARCEL E				
IR-01	IR01MW42A	IR01MWI-9		
IR-02	IR02MW300A	IR02MW373A	IR02MW97A	
IR-04	IR04MW31A			
IR-12	IR12MW12A	IR12MW19A		
IR-36	PA36MW04A			

Notes: Wells require redevelopment due to accumulated sediment within screened interval (between 10 and 50 percent of screened interval).

* Wells redeveloped in June and July 2000.

TABLE 4-1 (Continued)

RESULTS OF WELL CONDITION SURVEY
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 4 of 6)

WELLS THAT ARE NOT AVAILABLE FOR SAMPLING		
IR Site	**Monitoring Well**	
PARCEL B		
IR-06	IR06MW22A-D	Well is abandoned
	IR06MW23A	Well is abandoned
	IR06MW27A	Well is abandoned
	IR06MW30A	Well is abandoned
	IR06MW32A-D	Well is abandoned
	IR06MW48F	Well is abandoned
	IR06MW51F	Well is abandoned
IR-07	IR07MW20A2	Well is silted more than 50 percent
	IR07MWP-1	Well is abandoned
	IR07MWP-2	Well is abandoned
	IR07MWS-1	Well is abandoned
	IR07MWS-2D	Well is abandoned
	IR07MWS-3	Well is abandoned
	IR07MWS-4D	Well is abandoned
IR-10	IR10MW15A	Well is abandoned
	IR10MW31A2	Well is abandoned
IR-18	IR18MW21A	Well is abandoned
	IR18P21A1	Well is abandoned
	IR18P21A2	Well is abandoned
IR-20	IR20MW01A	Well is abandoned
	IR20MW06A	Well is abandoned
	IR20MW11A	Well is abandoned
IR-23	IR23MW14A	Well is abandoned
IR-24	IR24MW04A	Well is abandoned
	PA24MW03A-D	Well is abandoned
IR-26	IR26MW36A	Well is abandoned
IR-46	IR46MW40A2	Well is abandoned
	IR46MW42A	Well is abandoned

TABLE 4-1 (Continued)

RESULTS OF WELL CONDITION SURVEY
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 5 of 6)

WELLS THAT ARE NOT AVAILABLE FOR SAMPLING		
IR Site	**Monitoring Well**	
PARCEL B (Continued)		
IR-50	IR50MW14A	Well contains product
IR-60	IR60MW04A IR60MW10A	Well is abandoned Well is abandoned
IR-62	UT02MW15A UT02MW16A	Well contains product Well has been abandoned
PARCEL C		
IR-25	IR25MW11A IR25MW22A	Well contains product Well contains product
IR-28	IR28MW129A IR28MW273F IR28MW290A PA28MW52A	Well contains product Well is abandoned Well has not been located Well contains product
PARCEL D		
IR-08	IR08MW39A IR08MW43A	Well is abandoned Well is abandoned
IR-09	IR09MW31A	Well access is obstructed
IR-16	PA16MW16A	Well is abandoned
IR-33	PA33MW36A	Well has not been located
IR-39	IR39MW35A	Well contains product
PARCEL E		
IR-01	IR01MW18A IR09MW09B IR01MW26B IR01MW400A IR01MW402A IR01MWI-6 IR01MWI-7 IR01MWI-8	Well contains product Well access is obstructed Well has not been located Lid of well could not be opened Well has not been located Well has not been located Lid of well could not be opened Well is silted more than 50 percent

TABLE 4-1 (Continued)

RESULTS OF WELL CONDITION SURVEY
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 6 of 6)

WELLS THAT ARE NOT AVAILABLE FOR SAMPLING		
IR Site	**Monitoring Well**	
PARCEL E (Continued)		
IR-02	IR02MW173A	Thick product was found in pipe
	IR02MWB-2	Well is abandoned
IR-03	IR03MW218A1	Well contains product
	IR03MW225A	Well contains product
	IR03MW226A	Well contains product
	IR03MW369A	Well contains product
	IR03MW370A	Well contains product
	IR03MWO-1	Well contains product
	IR03MWO-2	Well contains product
	IR03MWO-3	Well contains product
IR-04	IR04MW35A	Well contains product
	IR04MW36A	Well contains product
	IR04MW39A	Well contains product
IR-05	IR05MW73A	Well contains product
	IR05MW74A	Well contains product
	IR05MW76A	Well has not been located
	IR05MW77A	Well contains product
	IR05MW82A	Well contains product
IR-12	IR12MW16A	Well contains product
	IR12MW21A	Well contains product
IR-13	IR13MW10A	Well has not been located
IR-36	IR36MW137A	Well is dry and access is obstructed
	IR36MW139A	Well has not been located
	PA36MW03A	Well is silted more than 50 percent
	PA36MW06A	Well has not been located
IR-56	IR56MW39A	Well contains product
IR-72	IR72MW32A	Well contains product
IR-73	IR73MW04A	Well contains product

Note:

IR Installation Restoration

TABLE 4-2

WELLS FOR WATER LEVEL MEASUREMENTS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well			
PARCEL B				
IR-06	IR06MW22A	IR06MW32A	IR06MW35A	IR06MW46A
IR-07	IR07MW19A	IR07MW20A1	IR07MW21A1	IR07MW21A2
	IR07MWS-4			
IR-10	IR10MW12A	IR10MW13A1	IR10MW14A	IR10MW28A
	IR10MW29A1	IR10MW32A	IR10MW33A	
IR-18	IR18MW21A	IR18MW100B	IR18MW101B	
IR-20	IR20MW17A			
IR-23	UT03MW11A	UT03MW12A		
IR-24	PA24MW02A	PA24MW03A		
IR-26	IR26MW41A	IR26MW44A		
IR-46	IR46MW37A	IR46MW38A	IR46MW39A	IR46MW43A
IR-50	PA50MW01A			
IR-61	IR61MW05A			
IR-62	IR62MW07A	IR62MW08A		
PARCEL C				
IR-25	IR06MW40A	IR06MW41A	IR06MW42A	IR06MW44A
	IR06MW45A	IR25MW16A	IR25MW17A	
IR-28	IR28MW122A	IR28MW149A	IR28MW200A	IR28MW311A
	IR28MW123A	IR28MW150A	IR28MW217A	IR28MW324A
	IR28MW124A	IR28MW151A	IR28MW268A	IR28MW326A
	IR28MW125A	IR28MW155A	IR28MW286A	IR28MW333A
	IR28MW126A	IR28MW169A	IR28MW287A	IR28MW338A
	IR28MW128A	IR28MW170A	IR28MW298A	IR28MW340A
	IR28MW136A	IR28MW171A	IR28MW308A	IR28MW314B
	IR28MW299B	IR28MW173B	IR28MW309B	PA28MW51A
IR-29	IR29MW48A	IR29MW57A	IR29MW84A	
IR-50	PA50MW03A	IR50MW04A		
IR-58	IR58MW26A	IR58MW31A	IR58MW32B	IR58MW33B
IR-64	IR64MW05A			

TABLE 4-2 (Continued)

WELLS FOR WATER LEVEL MEASUREMENTS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 3)

IR Site	Monitoring Well			
PARCEL D				
IR-08	IR08MW44A			
IR-09	IR09MW35A IR09MW36A	IR09MW37A IR09MW38A	IR09MW39A IR09MW44A	IR09MW52A
IR-16	PA16MW17A			
IR-22	IR22MW20A			
IR-32	PA32MW04A			
IR-33	IR33MW116A IR33MW61A	IR33MW62A IR33MW63A	IR33MW64A IR33MW65A	IR33MW66A PA33MW37A
IR-34	IR34MW01A	IR34MW02A		
IR-35	IR35MW01A			
IR-36	IR36MW16A			
IR-37	IR37MW01A			
IR-38	IR38MW01A	IR38MW02A	IR38MW03A	
IR-39	IR39MW21A IR39MW22A	IR39MW23A IR39MW24A	IR39MW33A PA39MW01A	PA39MW02A
IR-50	PA50MW05A PA50MW09A	PA50MW06A PA50MW11A	PA50MW07A PA50MW12A	PA50MW08A
IR-55	IR55MW04A			
IR-67	IR67MW04A			
IR-70	IR70MW04A	IR70MW11A		
IR-71	IR71MW03A			
PARCEL E				
IR-01	IR01MW02B IR01MW03A IR01MW07A IR01MW17B	IR01MW31A IR01MW367A IR01MW43A IR01MW44A	IR01MW47B IR01MW48A IR01MW53B IR01MW58A	IR01MW62A IR01MWI-2 IR01MWI-3 IR01MWI-5

TABLE 4-2 (Continued)

WELLS FOR WATER LEVEL MEASUREMENTS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 3 of 3)

IR Site	Monitoring Well			
PARCEL E (Continued)				
IR-02	IR02MW101A1 IR02MW114A1 IR02MW126A IR02MW127B IR02MW146A	IR02MW175A IR02MW179A IR02MW196A IR02MW206A1 IR02MW210B	IR02MW298A IR02MW299A IR02MW372A IR02MW87A IR02MW89A	IR02MW93A IR02MWB-1 IR02MWB-3 IR02MWB-5
IR-03	IR03MW218A2 IR03MW218A3	IR03MW224A IR03MW228B	IR03MW342A IR03MW371A	
IR-04	IR04MW13A	IR04MW37A	IR04MW40A	
IR-12	IR12MW11A IR12MW13A	IR12MW14A IR12MW15A	IR12MW17A IR12MW20A	
IR-13	IR13MW12A			
IR-14	IR14MW09A	IR14MW10A	IR14MW12A	IR14MW13A
IR-15	IR15MW06A	IR15MW07A	IR15MW08A	
IR-36	IR36MW09A IR36MW11A IR36MW120B IR36MW121A	IR36MW123B IR36MW126A IR36MW128A IR36MW129B	IR36MW135A IR36MW14A IR36MW12A IR36MW17A	PA36MW01A PA36MW02A PA36MW08A IR36MW122A
IR-50	PA50MW10A			
IR-74	IR74MW01A			

Notes: Wells proposed for water level measurement study

IR Installation restoration

TABLE 4-3

WELLS FOR CONFIRMATION LAND SURVEY
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	
PARCEL B		
IR-23	UT03MW11A	
IR-26	IR26MW41A	
IR-50	PA50MW01A	
PARCEL C		
IR-25	IR06MW45A	IR25MW11A
IR-28	IR28MW123A IR28MW128A	IR58MW32B
IR-29	IR29MW57A	
IR-58	IR58MW26A	
PARCEL D		
IR-09	IR09MW44A	
IR-22	IR22MW15A	
IR-38	IR38MW02A	
IR-50	PA50MW11A	
IR-70	IR70MW11A	
IR-71	IR71MW03A	
PARCEL E		
IR-01	IR01MW53B	
	IR01MW48A	
IR-02	IR02MW114A1	
IR-11	IR11MW25A	
IR-12	IR12MW14A	
IR-36	PA36MW02A	IR36MW11A
IR-50	PA50MW10A	

Note: Top of casing elevations at above wells will be re-surveyed to confirm previous survey measurement

IR Installation Restoration

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data								Fate and Transport Data												
									Monitored Natural Attenuation												
	Laboratory Analyses								Laboratory Analyses					Field Measurement			Laboratory	Laboratory	Field Measurement		
Well No.	Metals (see comments)	Cr VI	PCBs (see comments)	Pesticides (see comments)	SVOCs (see comments)	TPH-e	TPH-p	VOCs (see comments)	Metals (Calcium, Magnesium, Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Carbonate	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Total Dissolved Solids	Salinity	Water Level	Near shore well--sample at low tide	Comments
Parcel C - IR-25																					
IR06MW22A					1	1	1	1									1		1		Recently-installed well from Parcel B TPH investigation activities, Pentachlorophenol is only SVOC analyte of concern, VOC analytes of concern include 1,4-DCB
IR06MW32A						1	1	1									1		1		Recently-installed well from Parcel B TPH investigation activities
IR06MW34A						1	1	1	1	1	1	1	1	1	1	1	1		1		
IR06MW40A						1	1	1	1	1	1	1	1	1	1	1	1		1		
IR06MW41A						1	1	1	1	1	1	1	1	1	1	1	1		1		
IR06MW44A	1					1	1	1	1	1	1	1	1	1	1	1	1		1		Cadmium and nickel only analytes of concern for metals
IR06MW45A						1	1	1	1	1	1	1	1	1	1	1	1		1		
IR25MW11A			1																		Free product sample to be collected without purging and to be analyzed for PCBs only
IR25MW15A1			1	1		1	1	1	1	1	1	1	1	1	1	1	1		1		Aroclor-1260/heptachlor epoxide only PCB/pesticide analytes of concern, VOC analytes of concern include 1,2-DCB and 1,4-DCB
IR25MW15A2			1			1	1	1	1	1	1	1	1	1	1	1	1		1		Aroclor-1260 only PCB analyte of concern, VOC analytes of concern include 1,2-DCB and 1,4-DCB
IR25MW16A			1		1	1	1	1	1	1	1	1	1	1	1	1	1		1		Aroclor-1260 only PCB analyte of concern, hexachloroethane only SVOC analyte of concern
IR25MW17A						1	1	1	1	1	1	1	1	1	1	1	1	1	1		
IR25MW22A			1																		Free product sample to be collected without purging and to be analyzed for PCBs only
IR25MW37A						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well, location pending pre-excavation characterization for Parcel B remedial action
IR25MW39A						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well
IR25MW40A						1	1	1	1	1	1	1	1	1	1	1	1		1		New well, location pending pre-excavation characterization for Parcel B remedial action
IR25MW41A						1	1	1	1	1	1	1	1	1	1	1	1		1		New well, location pending pre-excavation characterization for Parcel B remedial action
IR25MW37B						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well, location pending pre-excavation characterization for Parcel B remedial action
IR25MW38B						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well, location pending pre-excavation characterization for Parcel B remedial action
IR25MW39B						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well
Total:	**1**	**0**	**5**	**1**	**2**	**18**	**18**	**18**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**18**	**6**	**18**		

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data								Fate and Transport Data												
									Monitored Natural Attenuation												
	Laboratory Analyses								Laboratory Analyses					Field Measure-ment			Laboratory	Laboratory	Field Measurement		
Well No.	Metals (see comments)	Cr VI	PCBs (see comments)	Pesticides (see comments)	SVOCs (see comments)	TPH-e	TPH-p	VOCs (see comments)	Metals (Calcium, Magnesium, Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Carbonate	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Total Dissolved Solids	Salinity	Water Level	Near shore well--sample at low tide	Comments
Parcel C - IR-28																					
IR28MW122A						1	1		1	1	1	1	1	1	1	1	1		1	1	
IR28MW124A						1	1	1									1		1	1	
IR28MW125A	1	1				1	1	1									1		1		Chromium and Cr VI only analytes of concern for metals
IR28MW126A						1	1	1									1		1		
IR28MW127A	1	1						1									1		1		Full suite of CLP metals and Cr VI
IR28MW136A						1	1	1	1	1	1	1	1	1	1	1	1	1	1		
IR28MW150A						1	1		1	1	1	1	1	1	1	1	1		1	1	
IR28MW151A						1	1	1	1	1	1	1	1	1	1	1	1	1	1		
IR28MW155A	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1		1		Chromium, Cr VI, and nickel only analytes of concern for metals, Aroclor-1260 only PCB analyte of concern
IR28MW169A						1	1	1									1		1		VOC analytes of concern include 1,4-DCB
IR28MW170A						1	1		1	1	1	1	1	1	1	1	1	1	1		
IR28MW171A			1														1		1	1	Aroclor-1260 only PCB analyte of concern
IR28MW200A						1	1	1	1	1	1	1	1	1	1	1	1		1	1	
IR28MW217A								1	1	1	1	1	1	1	1	1	1	1	1		
IR28MW269A						1	1										1		1	1	
IR28MW270A								1	1	1	1	1	1	1	1	1	1		1	1	
IR28MW272A								1									1		1	1	
IR28MW286A						1	1		1	1	1	1	1	1	1	1	1		1		
IR28MW287A						1	1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW293A								1									1		1	1	
IR28MW298A						1	1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW308A						1	1										1		1		
IR28MW311A	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		Manganese only analyte of concern for metals, heptachlor epoxide only pesticide analyte of concern, benzo(a)pyrene only SVOC analyte of concern

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data								Fate and Transport Data												
									Monitored Natural Attenuation								Laboratory	Laboratory	Field Measurement		
	Laboratory Analyses								Laboratory Analyses					Field Measure-ment							
Well No.	Metals (see comments)	Cr VI	PCBs (see comments)	Pesticides (see comments)	SVOCs (see comments)	TPH-e	TPH-p	VOCs (see comments)	Metals (Calcium, Magnesium, Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Carbonate	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Total Dissolved Solids	Salinity	Water Level	Near shore well--sample at low tide	Comments
Parcel C - IR-28																					
IR28MW331A								1	1	1	1	1	1	1	1	1	1		1		
IR28MW339A								1	1	1	1	1	1	1	1	1	1	1	1		
IR28MW394A						1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	New well
IR28MW396A						1	1	1									1	1	1		New well
IR28MW397A						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well
IR28MW398A						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well
PA28MW50A						1	1	1	1	1	1	1	1	1	1	1	1		1	1	
PA28MW51A						1	1	1	1	1	1	1	1	1	1	1	1	1	1		
PA50MW03A								1									1		1	1	
IR58MW31A			1			1	1	1	1	1	1	1	1	1	1	1	1	1	1		Aroclor-1260 only PCB analyte of concern, VOC analytes of concern include 1,2-DCB and 1,4-DCB
IR28MW173B								1	1	1	1	1	1	1	1	1	1	1	1		
IR28MW299B								1	1	1	1	1	1	1	1	1	1		1		
IR28MW309B								1									1		1		
IR28MW314B								1	1	1	1	1	1	1	1	1	1	1	1		
IR58MW32B								1	1	1	1	1	1	1	1	1	1		1		
IR58MW33B								1	1	1	1	1	1	1	1	1	1	1	1		VOC analytes of concern include 1,4-DCB
IR28MW393B						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well
IR28MW394B						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well
IR28MW395B						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well
IR28MW396B						1	1	1									1	1	1		New well
IR28MW397B						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well
IR28MW398B						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well
IR28MW399B						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well
IR28MW400B						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well
IR28MW401B						1	1	1	1	1	1	1	1	1	1	1	1	1	1		New well

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data								Fate and Transport Data												
									Monitored Natural Attenuation												
	Laboratory Analyses								Laboratory Analyses					Field Measure-ment			Laboratory	Laboratory	Field Measurement		
Well No.	Metals (see comments)	Cr VI	PCBs (see comments)	Pesticides (see comments)	SVOCs (see comments)	TPH-e	TPH-p	VOCs (see comments)	Metals (Calcium, Magnesium, Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Carbonate	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Total Dissolved Solids	Salinity	Water Level	Near shore well--sample at low tide	Comments
Parcel C - IR-28																					
IR28MW172F								1	1	1	1	1	1	1	1	1	1		1		
IR28MW188F								1									1		1		
IR28MW189F								1									1		1		
IR28MW190F								1	1	1	1	1	1	1	1	1	1		1		
IR28MW201F								1	1	1	1	1	1	1	1	1	1		1		
IR28MW211F								1	1	1	1	1	1	1	1	1	1		1		
IR28MW216F								1									1		1		
IR28MW275F								1									1		1		
IR28MW300F								1									1		1		
IR28MW310F								1									1	1	1		
IR28MW312F								1									1		1		
Total:	**4**	**3**	**3**	**1**	**1**	**33**	**33**	**52**	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**59**	**25**	**59**	**12**	
Parcel C - IR-29																					
IR29MW57A						1	1	1	1	1	1	1	1	1	1	1	1		1		
PA50MW04A						1	1										1		1		
IR29MW56F						1	1										1		1		
IR29MW72F						1	1	1									1		1		
Total:	**0**	**0**	**0**	**0**	**0**	**4**	**4**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**4**	**0**	**4**	**0**	
Parcel C - IR-58																					
IR58MW26A						1	1		1	1	1	1	1	1	1	1	1		1		
IR58MW25F	1	1							1	1	1	1	1	1	1	1	1		1		Chromium, Cr VI only analytes of concern for metals
Total:	**1**	**1**	**0**	**0**	**0**	**1**	**1**	**0**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**0**	**2**	**0**	

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data								Fate and Transport Data												
									Monitored Natural Attenuation												
	Laboratory Analyses								Laboratory Analyses					Field Measure-ment			Laboratory	Laboratory	Field Measurement		
Well No.	Metals (see comments)	Cr VI	PCBs (see comments)	Pesticides (see comments)	SVOCs (see comments)	TPH-e	TPH-p	VOCs (see comments)	Metals (Calcium, Magnesium, Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Carbonate	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Total Dissolved Solids	Salinity	Water Level	Near shore well--sample at low tide	Comments
Parcel D - IR-09																					
IR09MW35A	1	1															1	1	1		Chromium, Cr VI, and nickel only analytes of concern for metals
IR09MW51F	1	1						1									1		1		Chromium, Cr VI, and nickel only analytes of concern for metals
IR09PPY1	1	1				1	1										1		1		Chromium, Cr VI, and nickel only analytes of concern for metals
IR09MW54A	1	1															1	1	1		New well (if well IR09MW31A cannot be located); Chromium, Cr VI, and nickel only analytes of concern for metals
IR09MW54B	1	1															1	1	1		New well; Chromium, Cr VI, and nickel only analytes of concern for metals
IR09MW55B	1	1															1	1	1		New well; Chromium, Cr VI, and nickel only analytes of concern for metals
Total:	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**4**	**6**	**0**	
Parcel D - IR-33 North																					
IR33MW61A	1					1	1	1									1		1		Chromium, arsenic, and nickel only analytes of concern for metals; Benzene only analyte of concern for VOCs
IR33MW62A						1	1										1		1		
IR33MW64A						1	1										1		1		
IR33MW65A						1	1										1		1		
IR33MW66A						1	1										1		1		
PA50MW11A						1	1										1		1		
Total:	**1**	**0**	**0**	**0**	**0**	**6**	**6**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**6**	**0**	
Parcel D - IR-33 South																					
IR09MW44A	1	1															1		1		Chromium, Cr VI, and nickel only analytes of concern for metals
IR09P043A	1	1															1		1		Chromium, Cr VI, and nickel only analytes of concern for metals
PA33MW37A	1	1															1	1	1		Chromium, Cr VI, lead and nickel only analytes of concern for metals
IR33MW120B	1	1															1	1	1		New well; Chromium, Cr VI, and nickel only analytes of concern for metals
IR33MW121B	1	1															1		1		New well; Chromium, Cr VI, and nickel only analytes of concern for metals
Total:	**5**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**2**	**5**	**0**	

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data								Fate and Transport Data												
									Monitored Natural Attenuation												
	Laboratory Analyses								Laboratory Analyses					Field Measure-ment			Laboratory	Laboratory	Field Measurement		
Well No.	Metals (see comments)	Cr VI	PCBs (see comments)	Pesticides (see comments)	SVOCs (see comments)	TPH-e	TPH-p	VOCs (see comments)	Metals (Calcium, Magnesium, Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Carbonate	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Total Dissolved Solids	Salinity	Water Level	Near shore well--sample at low tide	Comments
Parcel D - IR-34																					
IR34MW01A	1					1	1	1									1		1		Chromium and nickel only analytes of concern for metals; Benzene only analyte of concern for VOCs
IR34MW36A	1					1	1	1									1	1	1		New well, Chromium and nickel only analytes of concern for metals; Benzene only analyte of concern for VOCs
IR34MW37A	1					1	1	1									1	1	1		New well, Chromium and nickel only analytes of concern for metals; Benzene only analyte of concern for VOCs
IR34MW36B	1					1	1	1									1	1	1		New well, Chromium and nickel only analytes of concern for metals; Benzene only analyte of concern for VOCs
IR34MW37B	1					1	1	1									1	1	1		New well, Chromium and nickel only analytes of concern for metals; Benzene only analyte of concern for VOCs
Total:	**5**	**0**	**0**	**0**	**0**	**5**	**5**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**4**	**5**	**0**	
Parcel D - IR-37																					
IR37MW26B	1	1															1		1		New well, Chromium and nickel only analytes of concern for metals
Total:	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	
Parcel D - IR-38																					
IR38MW03A						1	1										1		1		
Total:	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	
Parcel D - IR-71																					
IR71MW03A								1									1	1	1		
IR71MW12B								1									1	1	1		New well
Total:	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**2**	**0**	

Grand total:	**18**	**10**	**8**	**2**	**3**	**69**	**69**	**80**	**57**	**57**	**57**	**57**	**57**	**57**	**57**	**57**	**109**	**43**	**109**	**12**

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Notes:

Analyte Information

Metals	Dissolved contract laboratory program (CLP) metals
Cr VI	Dissolved hexavalent chromium
PCBs	Polychlorinated biphenyls
SVOCs	Semivolatile organic compounds
TPH-e	Total petroleum hydrocarbons - extractable (diesel range/motor oil range)
TPH-p	Total petroleum hydrocarbons - purgeable (gasoline range)
VOCs	Volatile organic compounds
DCB	Dichlorobenzene

Well Type

A	A-aquifer
B	B-aquifer
F	Bedrock water-bearing zone

Refer to Tables 4-5 and 4-6 of FSP for specific rationale for sampling at each well

Refer to Table 2-1 (Appendix 2 of accompanying QAPP) for specific groundwater analytical protocol (analytical method, sample volumes & containers, preservation, holding time, etc.)

In accordance with standard groundwater sampling procedures, groundwater temperature, pH, and conductivity measurements will be made with field equipment to ensure that samples are collected from representative formation water. Turbidity will also be measured with field equipment to monitor for particulate interference.

QA/QC Samples:	**Equipment Rinsate**: One per day per parameter. **Field Duplicate**: One for every 10 wells or portion thereof.	**Trip Blank:** One per transport container containing samples for VOC analysis. **Source Water Blank**: One per source per event, as nec.	**Matrix Spike/Matrix Spike Duplicate:** One for every 20 wells sampled or portion thereof. Requires double volume of water to be collected.

TABLE 4-5

PARCEL C WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-25 (A-aquifer)	IR06MW34A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR06MW40A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR06MW41A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR06MW44A	• VOCs • Cadmium • Nickel • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs, metals, and TPH • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR06MW45A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW15A1	• VOCs (incl. 1,2-DCB and 1,4-DCB) • Aroclor-1260 • Heptachlor epoxide • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow contaminants • Concentrations of VOCs and SVOCs exceeded MCLs in multiple rounds • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 12)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-25 (A-aquifer) (cont.)	IR25MW15A2	• VOCs (incl. 1,2-DCB and 1,4-DCB) • Aroclor-1260 • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, deeper contaminants • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW16A	• VOCs • Aroclor-1260 • Hexachloroethane • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow contaminants • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW17A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW37A* (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW38A* (new well)	• VOCs • TPH-extractables • TPH-purgeables • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR25MW39A (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 3 of 12)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-25 (A-aquifer) (cont.)	IR25MW40A* (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, deeper VOCs and TPH (to be screened at bottom of A-aquifer) • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW41A* (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, deeper VOCs and TPH (to be screened at bottom of A-aquifer) • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-25 (B-aquifer)	IR25MW37B* (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C5 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW38B* (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C5 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW39B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C5 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-28 (A-aquifer)	IR28MW122A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 4 of 12)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont.)	IR28MW124A	• VOCs • TPH-extractables • TPH-purgeables • TDS	• Confirm extent of RU-C1 • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR28MW125A	• VOCs • Chromium • TPH-extractables • TPH-purgeables • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR28MW126A	• VOCs • TPH-extractables • TPH-purgeables • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR28MW127A	• Metals • VOCs • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Obtain TDS data for beneficial use analysis
	IR28MW136A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW150A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW151A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 5 of 12)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont.)	IR28MW155A	• VOCs • TPH-extractables • Aroclor-1260 • Chromium • Nickel • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Confirm extent of ecological RU-7 (well IR28MW129A not available for sampling) • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW169A	• VOCs (incl 1,4-DCB) • TPH-extractables • TPH-purgeables • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR28MW170A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW171A	• Aroclor-1260 • TDS	• Confirm extent of ecological RU-3 • Obtain TDS data for beneficial use analysis
	IR28MW200A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW217A	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW269A	• TPH-extractables • TPH-purgeables • TDS	• Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR28MW270A	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW272A	• VOCs • TDS	• Confirm extent of RU-C4 and RU-C7 • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 6 of 12)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont.)	IR28MW286A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C2 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW287A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C2 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW293A	• VOCs • TDS	• Confirm extent of RU-C4 and RU-C7 • Obtain TDS data for beneficial use analysis
	IR28MW298A	• VOCs • TPH-extractables • TPH-purgeables • TDS	• Confirm extent of RU-C4 • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR28MW308A	• TPH-extractables • TPH-purgeables • TDS	• Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR28MW311A	• VOCs • Benzo(a)pyrene • Heptachlor epoxide • Manganese • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW331A	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW339A	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 7 of 12)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont.)	IR28MW394A (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C4, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW396A (new well)	• VOCs • TPH-extractables • TPH-purgeables • TDS	• Confirm extent of RU-C2, shallow VOCs and TPH • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR28MW397A (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C2, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW398A (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C2, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	PA28MW50A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	PA28MW51A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	PA50MW03A	• VOCs • TDS	• Confirm extent of RU-C1 • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 8 of 12)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont.)	IR58MW31A	• VOCs (incl 1,2-DCB and 1,4-DCB) • Aroclor-1260 • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C2 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-28 (B-aquifer)	IR28MW173B	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW299B	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW309B	• VOCs • TDS	• Confirm extent of RU-C1 • Obtain TDS data for beneficial use analysis
	IR28MW314B	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR58MW32B	• VOCs • MNA • TDS	• Confirm extent of RU-C2 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings
	IR58MW33B	• VOCs (incl 1,4-DCB) • MNA • TDS	• Confirm extent of RU-C2 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW393B (New well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C4 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 9 of 12)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (B-aquifer) (cont.)	IR28MW394B (New well)	• VOCs • TPH-extractables • TPH-purgeables • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C4 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR28MW395B (New well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C7 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW396B (New well)	• VOCs • TPH-extractables • TPH-purgeables • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C2 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR28MW397B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C2 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW398B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C2 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 10 of 12)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (B-aquifer) (cont.)	IR28MW399B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C1 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW400B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C1 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW401B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C1 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-28 (bedrock wells)	IR28MW172F	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW188F	• VOCs • TDS	• Confirm extent of RU-C7 • Most recent sampling event in 1995 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Obtain TDS data for beneficial use analysis
	IR28MW189F	• VOCs • TDS	• Confirm extent of RU-C7 • Most recent sampling event in 1995 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 11 of 12)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (bedrock wells) (cont.)	IR28MW190F	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW201F	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW211F	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Only one round of sampling was conducted for cis-1,2-dichloroethene and 1,1,2-trichloroethane • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW216F	• VOCs • TDS	• Confirm extent of RU-C7 • Obtain TDS data for beneficial use analysis
	IR28MW275F	• VOCs • TDS	• Confirm extent of RU-C7 • Obtain TDS data for beneficial use analysis
	IR28MW300F	• VOCs • TDS	• Confirm extent of RU-C7 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Obtain TDS data for beneficial use analysis
	IR28MW310F	• VOCs • TDS	• Confirm extent of RU-C7 • Obtain TDS data for beneficial use analysis
	IR28MW312F	• VOCs • TDS	• Confirm extent of RU-C7 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Obtain TDS data for beneficial use analysis
IR-29 (A-aquifer)	IR29MW57A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	PA50MW04A	• TPH-extractables • TPH-purgeables • TDS	• Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 12 of 12)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-29 (bedrock wells)	IR29MW56F	• TPH-extractables • TPH-purgeables • TDS	• Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR29MW72F	• Benzene • TPH-extractables • TPH-purgeables • TDS	• Confirm benzene concentrations • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
IR-58 (A-aquifer)	IR58MW26A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-58 (bedrock wells)	IR58MW25F	• Chromium • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Confirm chromium contamination • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

Notes:

MNA parameters include: reduced metals iron (II) and iron (III), nitrate, nitrite, sulfate, dissolved oxygen, chloride, carbonate, calcium, magnesium, sodium, potassium, and total dissolved solids (TDS)

*	Locations of well is pending pre-excavation characterization for Parcel B remedial action
BCT	Base Realignment and Closure (BRAC) Cleanup Team
CAP	Corrective action plan
DCB	Dichlorobenzene
HGAL	Hunters Point groundwater ambient level
MCL	Maximum contaminant level
MNA	Monitored natural attenuation
RU	Remedial unit
SVOC	Semivolatile organic compounds
TDS	Total dissolved solids
TPH	Total petroleum hydrocarbons
VOC	Volatile organic compounds

TABLE 4-6

PARCEL D WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-09 (A-aquifer)	IR09MW35A	• Chromium, Cr VI • Nickel • TDS	• Confirm chromium and nickel concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Obtain TDS data for beneficial use analysis
	IR09MW51F	• Chromium, Cr VI • Nickel • Trichloroethene • Methylene chloride • TDS	• Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Obtain TDS data for beneficial use analysis
	IR09PPY1	• Chromium, Cr VI • Nickel • TPH-extractables • TPH-purgeables • TDS	• Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
IR-09 (B-aquifer)	IR09MW54B (new well)	• Chromium, Cr VI • Nickel • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-D1 have migrated to the B-aquifer • Obtain TDS data for beneficial use analysis
	IR09MW55B (new well)	• Chromium, Cr VI • Nickel • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine if chemicals from RU-D1 have migrated to the B-aquifer • Obtain TDS data for beneficial use analysis
IR-33 North (A-aquifer)	IR33MW61A	• Benzene • Chromium, Cr VI • Nickel • Arsenic • TPH-extractables • TPH-purgeables • TDS	• Confirm chromium, nickel, and benzene concentrations • Evaluate potential relationship of nickel concentrations to surrounding chromium concentrations • Isolated detection of arsenic, followed by two rounds below MCLs • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR33MW62A	• TPH-extractables • TPH-purgeables • TDS	• Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis

TABLE 4-6 (Continued)

PARCEL D WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 4)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-33 North (A-aquifer)	IR33MW64A	• TPH-extractables • TPH-purgeables • TDS	• Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR33MW65A	• TPH-extractables • TPH-purgeables • TDS	• Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR33MW66A	• TPH-extractables • TPH-purgeables • TDS	• Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	PA50MW11A	• TPH-extractables • TPH-purgeables • TDS	• Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
IR-33 South (A-aquifer)	IR09MW44A	• Chromium, Cr VI • Nickel • TDS	• Evaluate potential relationship of nickel concentrations to surrounding chromium concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Obtain TDS data for beneficial use analysis
	IR09P043A	• Chromium, Cr VI • Nickel • TDS	• Confirm chromium and nickel concentrations • Evaluate potential relationship of nickel concentrations to surrounding chromium concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Obtain TDS data for beneficial use analysis
	PA33MW37A	• Chromium, Cr VI • Nickel • Lead • TDS	• Isolated nickel and lead concentrations above MCLs, followed by one round with results below the MCL • Evaluate potential relationship of nickel concentrations to surrounding chromium concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Obtain TDS data for beneficial use analysis
IR-33 South (B-aquifer)	IR33MW120B (new well)	• Chromium, Cr VI • Nickel • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-D1 have migrated to the B-aquifer • Obtain TDS data for beneficial use analysis

TABLE 4-6 (Continued)

PARCEL D WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 3 of 4)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-33 South (B-aquifer)	IR33MW121B (new well)	• Chromium, Cr VI • Nickel • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-D1 have migrated to the B-aquifer • Obtain TDS data for beneficial use analysis
IR-34 (A-aquifer)	IR34MW01A	• Chromium • Nickel • Benzene • TPH-extractables • TPH-purgeables • TDS	• Confirm chromium, nickel, and benzene concentrations • Evaluate potential relationship of nickel concentrations to surrounding chromium concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR34MW36A (new well)	• Chromium • Nickel • Benzene • TPH-extractables • TPH-purgeables • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from upgradient areas have migrated to the B-aquifer • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR34MW37A (new well)	• Chromium • Nickel • Benzene • TPH-extractables • TPH-purgeables • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from upgradient areas have migrated to the B-aquifer • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
IR-34 (B-aquifer)	IR34MW36B (new well)	• Chromium • Nickel • Benzene • TPH-extractables • TPH-purgeables • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from upgradient areas have migrated to the B-aquifer • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
	IR34MW37B (new well)	• Chromium • Nickel • Benzene • TPH-extractables • TPH-purgeables • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from upgradient areas have migrated to the B-aquifer • Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis

TABLE 4-6 (Continued)

PARCEL D WELLS FOR RESAMPLING
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 4 of 4)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-37 (A-aquifer)	IR37MW26B (new well)	• Chromium, Cr VI • Nickel • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-D1 have migrated to the B-aquifer • Obtain TDS data for beneficial use analysis
IR-38 (A-aquifer)	IR38MW03A	• TPH-extractables • TPH-purgeables • TDS	• Provide additional data for petroleum CAP • Obtain TDS data for beneficial use analysis
IR-71 (A-aquifer)	IR71MW03A	• VOCs • TDS	• Confirm trichloroethene, tetrachloroethene, and carbon tetrachloride concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Obtain TDS data for beneficial use analysis
IR-71 (B-aquifer)	IR71MW12B (new well)	• VOCs • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from the A-aquifer have migrated to the B-aquifer • Obtain TDS data for beneficial use analysis

Notes:

BCT Base Realignment and Cleanup (BRAC) Closure Team
CAP Corrective action plan
Cr VI Hexavalent chromium
MCL Maximum contaminant level
RU Remedial unit
TDS Total dissolved solids
TPH Total petroleum hydrocarbons
VOC Volatile organic compound

TABLE 4-7

WELL CONSTRUCTION SPECIFICATIONS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

(Page 1 of 1)

Parcel	IR Site	Monitoring Well			Typical Construction Specifications *
A-AQUIFER WELLS					
Parcel C	IR-25	IR25MW37A IR25MW39A	IR25MW40A	IR25MW41A	• Casing diameter: 2 to 4 inches • Total depth: 15 to 30 feet below ground surface • Screen length: 10 feet • Screen interval to extend at least one foot above maximum seasonal groundwater elevation
	IR-28	IR28MW394A IR28MW396A	IR28MW397A	IR28MW398A	
Parcel D	IR-09	IR09MW54A			
	IR-34	IR34MW36A	IR34MW37A		
B-AQUIFER WELLS					
Parcel C	IR-25	IR25MW37B	IR25MW38B	IR25MW39B	• Casing diameter: 4 to 6 inches • Total depth: 35 to 75 feet below ground surface (to bedrock surface) • Screen length: 10 feet • Screen interval to be placed at bottom of B-aquifer (above bedrock surface)
	IR-28	IR28MW393B IR28MW394B IR28MW395B	IR28MW396B IR28MW397B IR28MW398B	IR28MW399B IR28MW400B IR28MW401B	
Parcel D	IR-09	IR09MW54B	IR09MW55B		
	IR-33	IR33MW120B	IR33MW121B		
	IR-34	IR34MW36B	IR34MW37B		
	IR-37	IR37MW26B			
	IR-71	IR71MW12B			

Notes:

* Well construction specifications will vary from location to location and are subject to change to accommodate site-specific conditions

IR Installation Restoration

TABLE 8-1

SCHEDULE
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Event	Beginning Date	Ending Date
Phase I DQOs		
Submit Phase I DQOs	April 18, 2000	April 18, 2000
BCT Review Period	April 18, 2000	May 1, 2000
BCT Comments Due	May 1, 2000	May 1, 2000
Phase I FSP/QAPP		
Submit Draft Phase I FSP/QAPP	June 1, 2000	June 1, 2000
BCT Review Period	June 1, 2000	June 23, 2000
BCT Comments Received	June 13, 2000	June 23, 2000
Prepare Responses to Comments	June 26, 2000	July 10, 2000
Submit Responses to Comments	July 10, 2000	July 10, 2000
Discuss Responses with BCT	June 26, 2000	July 13, 2000
Prepare Final Phase I FSP/QAPP	July 14, 2000	July 28, 2000
Submit Final Phase I FSP/QAPP	July 31, 2000	July 31, 2000
Phase I Field Activities		
Well Inspection	March 28, 2000	May 5, 2000
Well Repairs	May 17, 2000	Ongoing Task
Well Redevelopment	June 28, 2000	Ongoing Task
Water Level Measurements (187 A-aquifer and 18 B aquifer wells)	July 12, 2000	July 12, 2000
Land Survey – Existing Wells	July 19, 2000	July 25, 2000
Phase I Sampling – Existing Wells	July 31, 2000	August 18, 2000
Phase I Well Installation	July 31, 2000	August 18, 2000
Water Level Measurement (20 new A- and B-aquifer well pairs)	August 21, 2000	August 21, 2000
Phase I Sampling – New Wells	August 21, 2000	August 25, 2000
Data Review		
Survey and Water Level Data Review	July 25, 2000	August 22, 2000
Preliminary Water Level Data Submittal	August 23, 2000	August 23, 2000
Laboratory Analysis/Data Validation, Management and Review	August 28, 2000	October 23, 2000

TABLE 8-1 (Continued)

SCHEDULE
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 2)

Event	Beginning Date	Ending Date
Data Review (continued)		
Phase I Information Package Submittal	October 23, 2000	October 23, 2000
Phase I Information Analysis Meeting/ Phase II Scoping with BCT	November 7, 2000	November 7, 2000

Notes:

BCT	Base Realignment and Closure Cleanup Team
DQO	Data quality objective
FSP	Field sampling plan
QAPP	Quality assurance project plan

TABLE 8-1 (Continued)

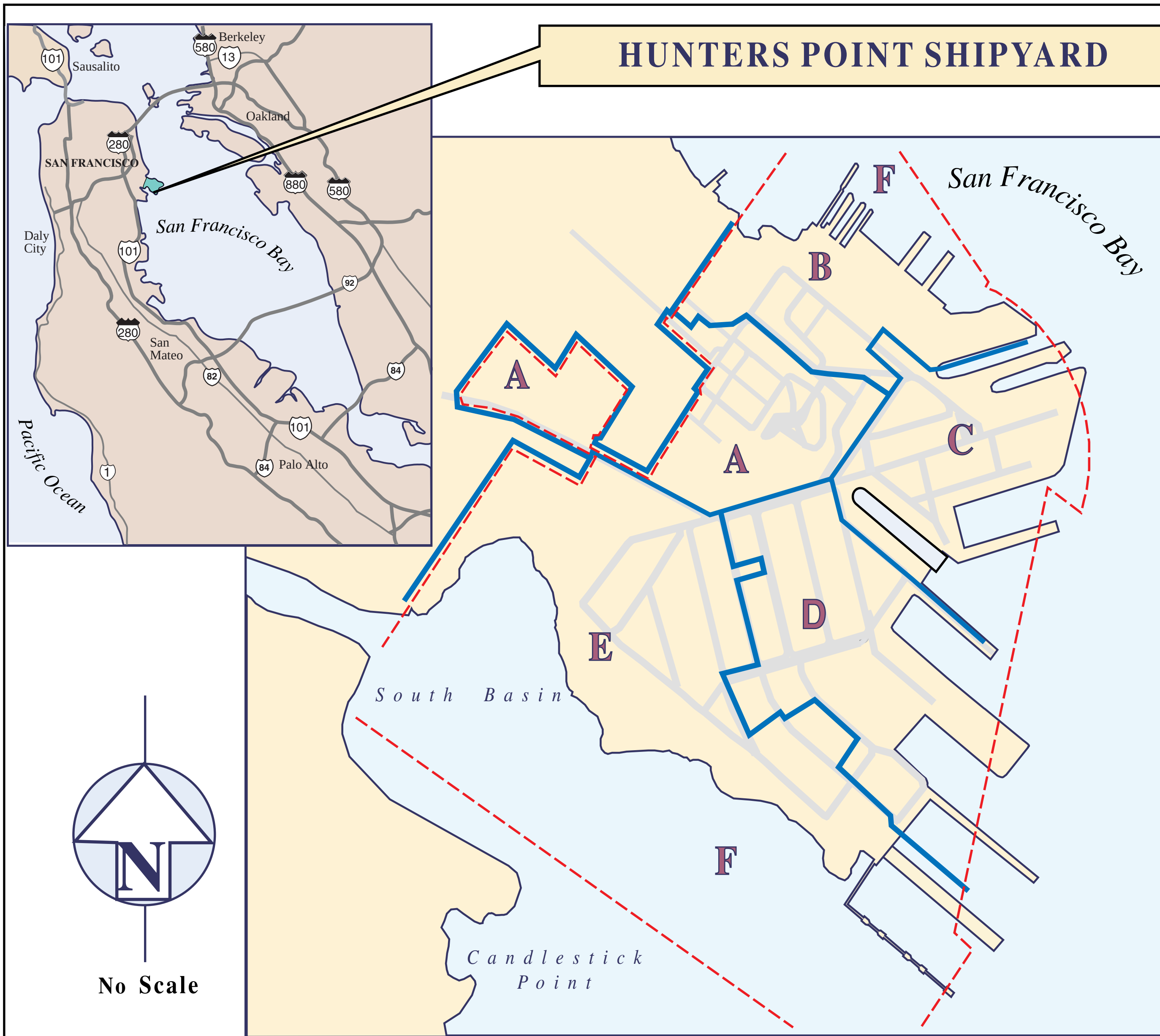
SCHEDULE
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 2)

Event	Beginning Date	Ending Date
Data Review (continued)		
Phase I Information Package Submittal	October 23, 2000	October 23, 2000
Phase I Information Analysis Meeting/ Phase II Scoping with BCT	November 7, 2000	November 7, 2000

Notes:

BCT	Base Realignment and Closure Cleanup Team
DQO	Data quality objective
FSP	Field sampling plan
QAPP	Quality assurance project plan

FIGURES



HUNTERS POINT SHIPYARD

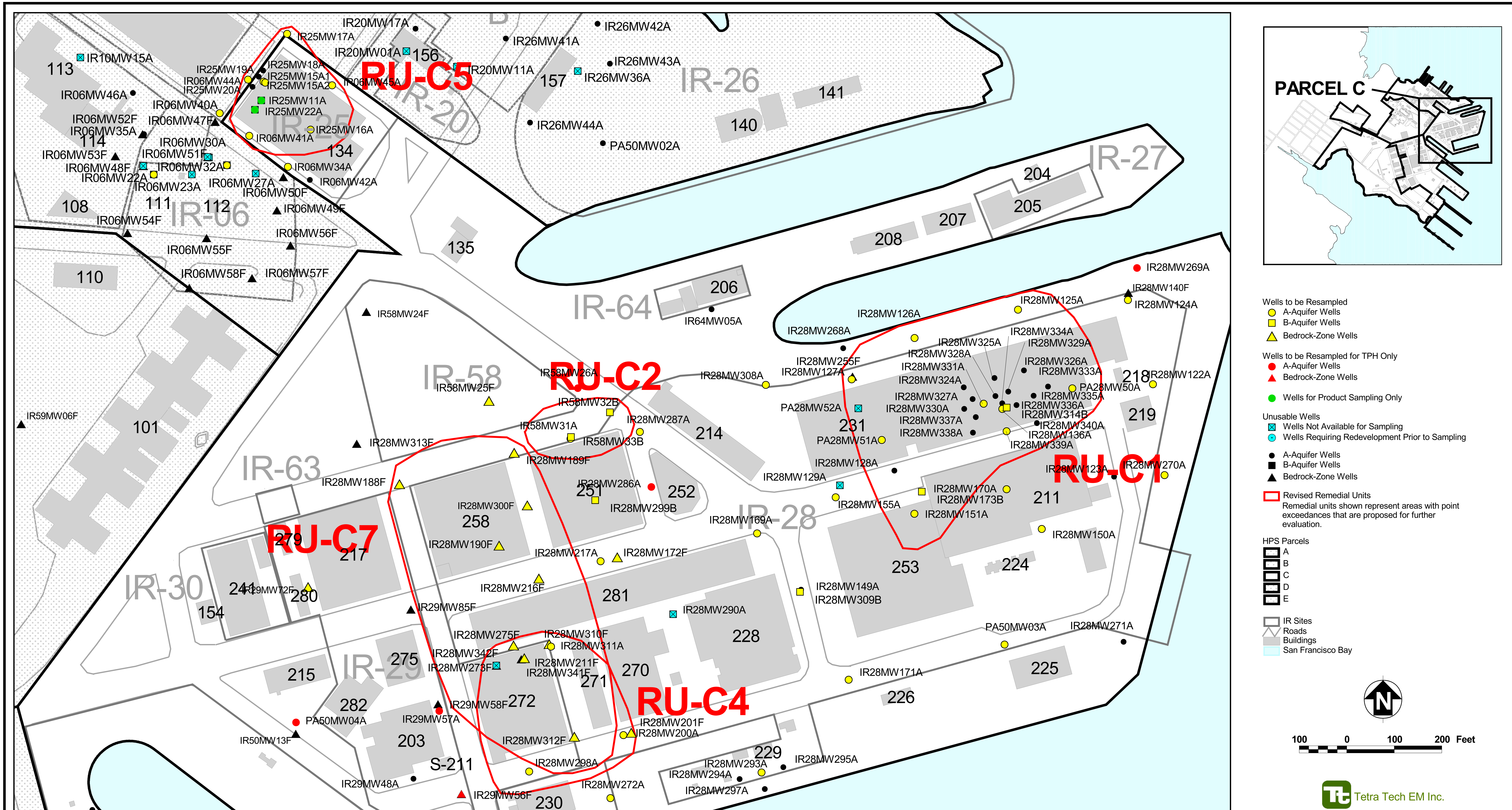
DEPARTMENT OF THE NAVY	NAVAL FACILITIES ENGINEERING COMMAND
SOUTHWEST DIVISION SAN DIEGO, CALIFORNIA	
HUNTERS POINT SHIPYARD	SAN FRANCISCO, CALIFORNIA

FIGURE 3-1
FACILITY LOCATION MAP
HUNTERS POINT SHIPYARD

HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE 4-1

BASEWIDE A-AQUIFER AND B-AQUIFER WELLS FOR WATER LEVEL MEASUREMENTS AND CONFIRMATION LAND SURVEY



HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE 4-2
PARCEL C
WELLS FOR RESAMPLING TO CONFIRM
EXTENT OF REMEDIAL UNITS

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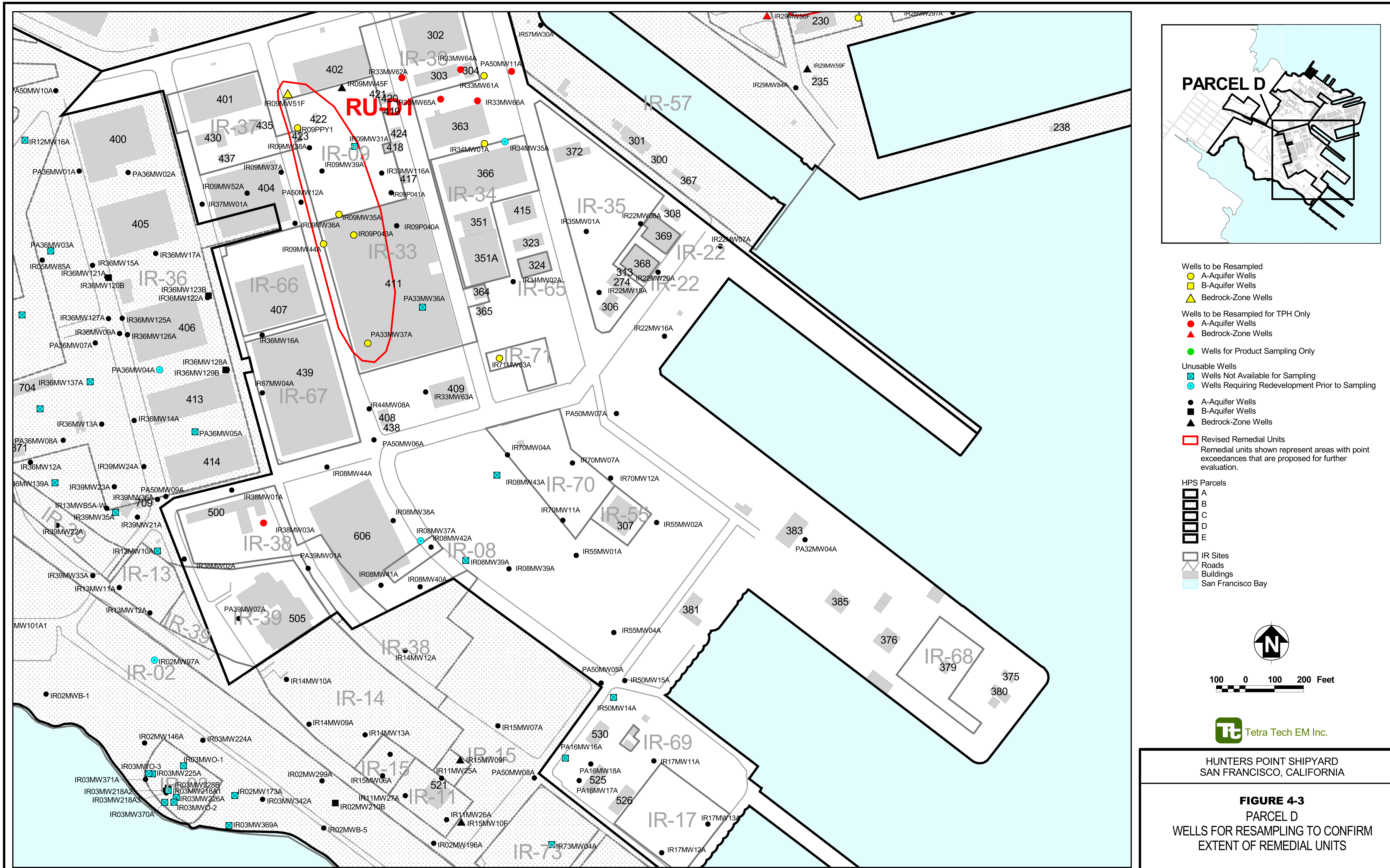

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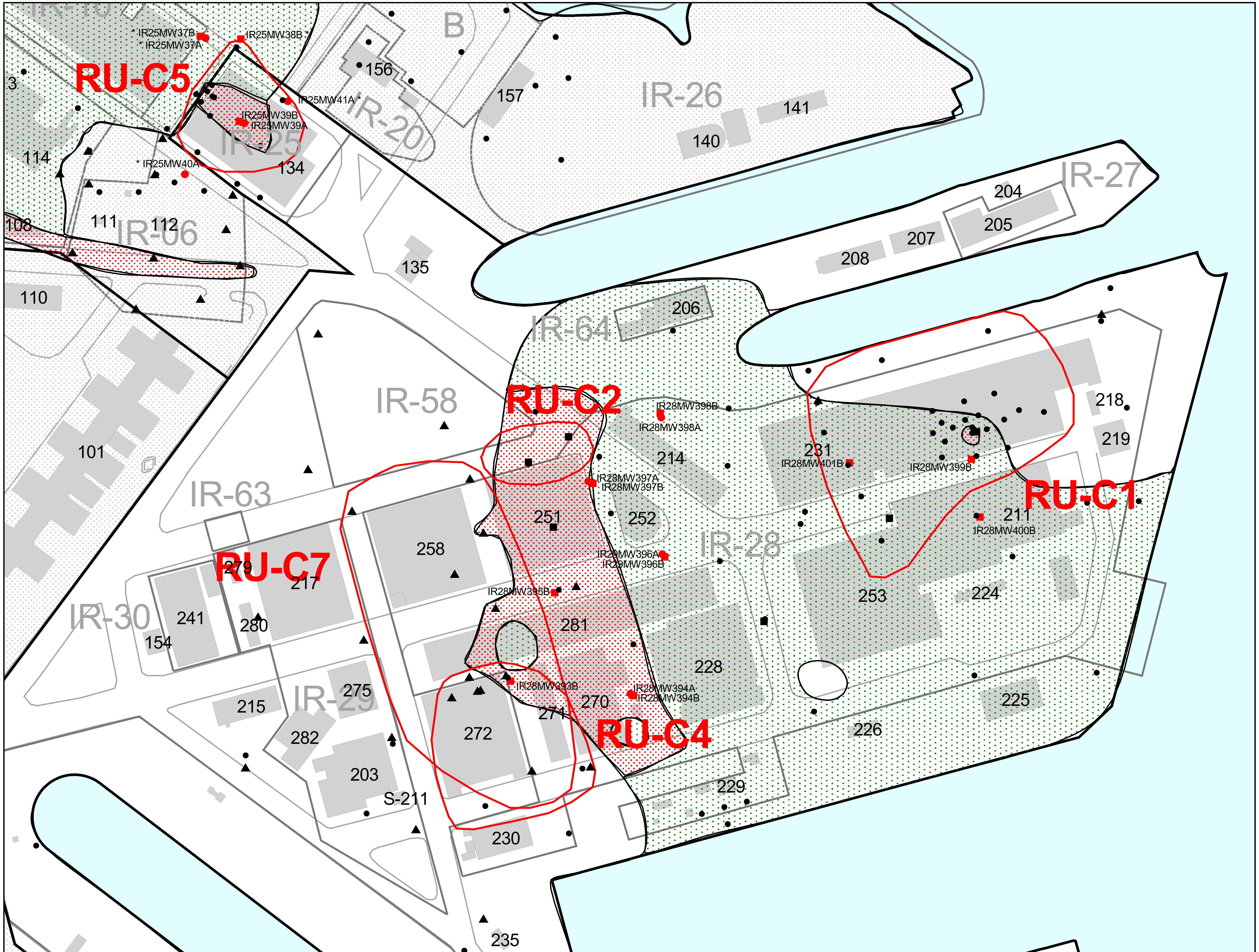

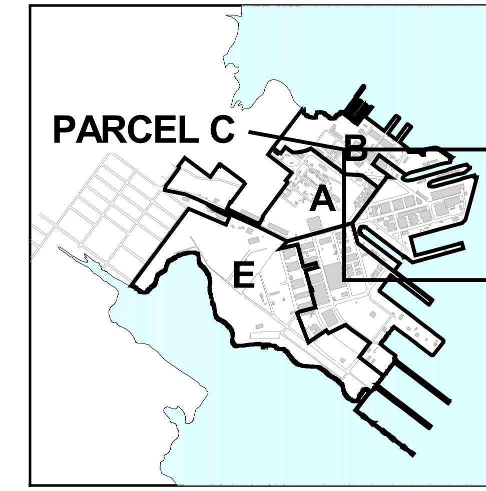

- A-Aquifer Wells
- B-Aquifer Wells
- Bedrock-Zone Wells

Proposed A & B Aquifer Wells
- A-Aquifer Wells
- B-Aquifer Wells

Revised Remedial Units
Remedial units shown represent areas with point exceedances that are proposed for further evaluation.

B Aquifer Distribution
- B Aquifer Absent
- B Aquifer Under A Aquifer
- B Aquifer Under Bay Mud

HPS Parcels
- A
- B
- C
- D
- E

- IR Sites
- Roads
- Buildings
- San Francisco Bay

*Tentative Well Locations Pending Pre-Excavation Characterization for Parcel B Remedial Action

N

100 0 100 200 Feet

Tetra Tech EM Inc.

HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE 4-4
PARCEL C
LOCATIONS FOR
NEW A- AND B-AQUIFER WELLS

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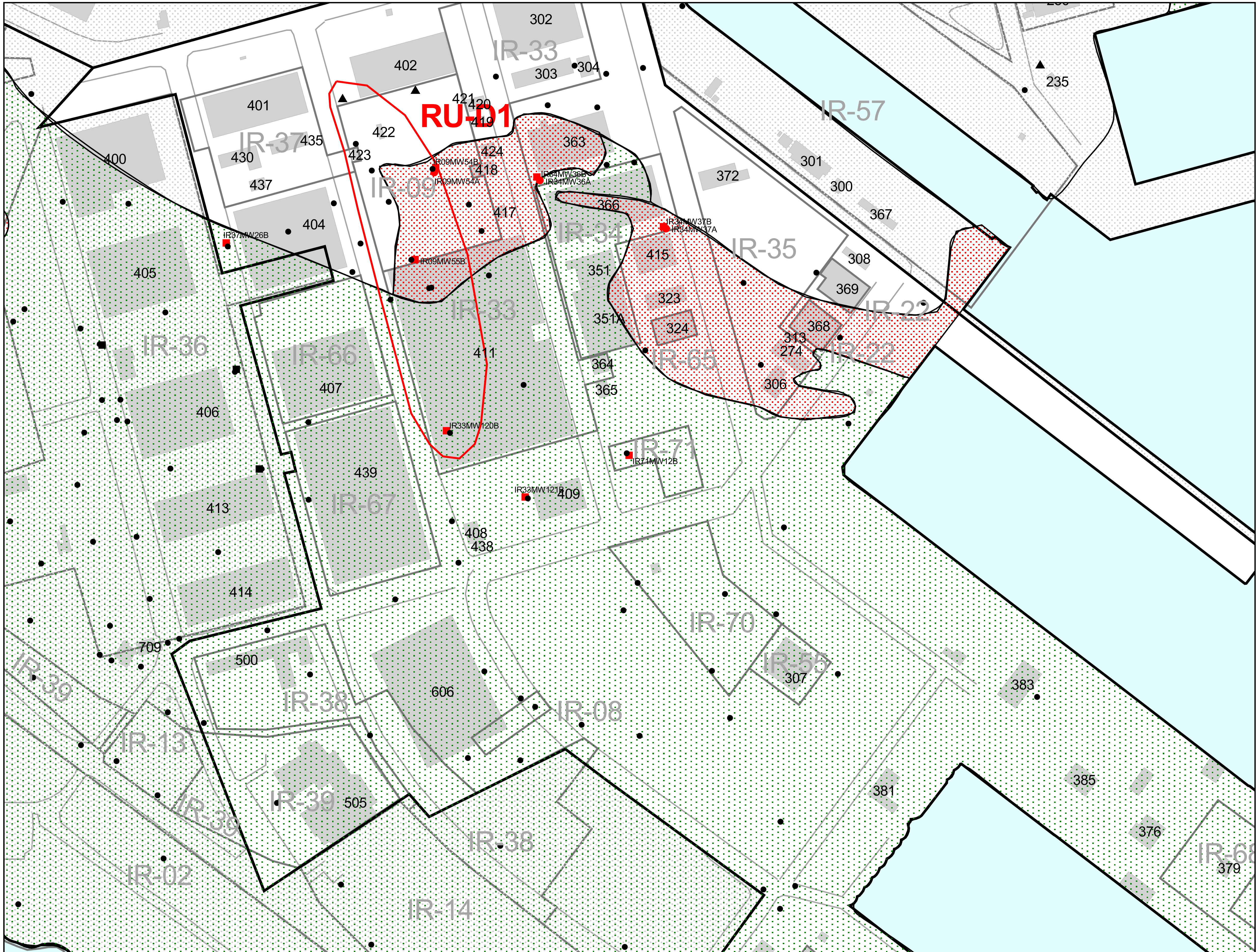

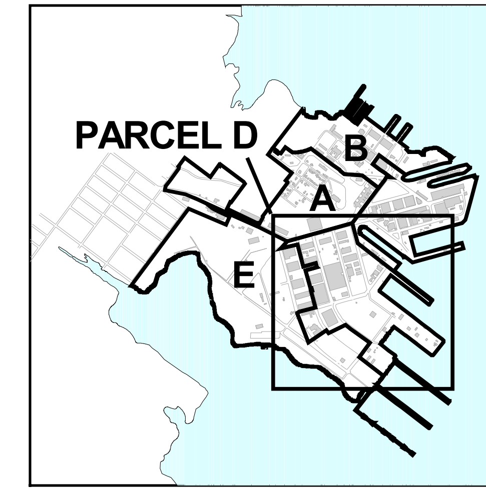

- A-Aquifer Wells
- B-Aquifer Wells
- Bedrock-Zone Wells

Proposed A & B Aquifer Wells

- A-Aquifer Wells
- B-Aquifer Wells

Revised Remedial Units

Remedial units shown represent areas with point exceedances that are proposed for further evaluation.

B Aquifer Distribution

- B Aquifer Absent
- B Aquifer Under A Aquifer
- B Aquifer Under Bay Mud

HPS Parcels

- A
- B
- C
- D
- E

- IR Sites
- Roads
- Buildings
- San Francisco Bay

N

100 0 100 200 Feet

Tetra Tech EM Inc.

HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE 4-5

PARCEL D
LOCATIONS FOR
NEW A- AND B-AQUIFER WELLS

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APPENDIX A

SUMMARY OF GROUNDWATER WORKING MEETINGS

PARCEL D GROUNDWATER EVALUATION
HUNTERS POINT SHIPYARD
MEETING MINUTES
February 7, 2000

These meeting minutes summarize the groundwater issues meeting for Parcel D of Hunters Point Shipyard (HPS). The meeting was held on February 7, 2000, at the San Francisco office of Tetra Tech EM, Inc. (TtEMI) and was attended by the Base Realignment and Closure (BRAC) Cleanup Team (BCT). A list of attendees is included as Attachment A. These meeting minutes discuss the key points, decisions, and action items agreed to at the meeting.

ANNOUNCEMENTS

Claire Trombadore of the U.S. Environmental Protection Agency (EPA) recommended that the results from the groundwater evaluation meetings should be summarized in a letter. In particular, Ms. Trombadore stated that the letter should specify which groundwater areas would be evaluated in the feasibility study (FS) addendum, specify which areas are recommended for no further action (NFA), and provide documentation (such as tables and figures) supporting the recommendations. In addition, Sheryl Lauth of EPA suggested that the letter also summarize the recommendations for Parcel C. Ms. Lauth and Ms. Trombadore indicated that the issuance of such a letter (or letters) would eliminate the need for any future groundwater technical memoranda for Parcels C, D, and E.

Ms. Trombadore provided the BCT with recommendations for the content of the Parcel D FS addendum. In particular, Ms. Trombadore indicated that Sections 3.0 and 4.0 of the draft final Parcel D FS be revised to include additional remedial alternatives (for example monitored natural attenuation for soil and groundwater areas, and institutional controls for soil areas), and to evaluate only the soil and groundwater areas specified in the risk management review and groundwater working meetings.

Ms. Trombadore stated that future meetings with the BCT should focus on the steps necessary to produce a record of decision (ROD) for Parcel D. The Navy indicated that it is considering proceeding with an NFA ROD for those Parcel D soil and groundwater areas where the BCT recommends no further action.

GROUNDWATER EVALUATION

Purpose/Process

The Navy stated that the purpose of the meeting was to evaluate groundwater areas for the following:

- Inclusion in the FS addendum for further remedial evaluation
- Additional sampling
- NFA

The evaluation was based on two criteria:

1. Chemical concentrations that exceed screening criteria
   - Maximum contaminant levels (MCL)/Hunters Point groundwater ambient levels (HGAL)
   - Temporal and spatial trends
2. Total dissolved solids (TDS)/well yield
   - TDS: Maximum values used for TDS contours presented
   - Yield: Assume that all wells meet criteria at A and B-aquifers

The Navy described the process of the meeting to consist of four steps:

1. Data presentation: Display all Parcel D groundwater data
2. Data presentation: Identify MCL/HGAL exceedances
3. Discussion: Evaluate Parcel D groundwater areas based on the two criteria
4. Discussion: Identify areas for inclusion in the FS addendum

Data Presentation

The BCT members reviewed the data for Parcel D using a Geographic Information System (GIS) platform. Data reviewed during the meeting included:

- All monitoring well groundwater data for metals, volatile organic compounds (VOC), semi-volatile organic compounds (SVOC), pesticides and polychlorinated biphenyls (PCB) with respect to MCLs and HGALs
- Specific monitoring wells with chemical concentrations exceeding the MCLs or HGALs
- TDS data from monitoring wells and HydroPunch borings
- Distribution of the B-aquifer (based on a facility-wide geologic interpretation of historic boring logs)
- Proposed soil remediation areas
- Conceptual groundwater flow patterns
- Utility line locations with respect to the wet-season groundwater table

Discussion

During the discussion period of the meeting, several BCT members commented upon the groundwater data as presented. Chris Maxwell of the San Francisco Bay Regional Water Quality Control Board (RWQCB) stated that the Navy should identify potential groundwater areas where HydroPunch groundwater data was not supplemented with groundwater data from monitoring wells. Mr. Maxwell stated that such data would need to be considered in groundwater evaluation prior to FS addendum.

Mr. Maxwell also indicated that the Navy should evaluate groundwater data with respect to National Ambient Water Quality Criteria (NAWQC) in areas of potential tidal influence prior to FS addendum (e.g., copper and mercury). The Navy clarified that an evaluation of the data with respect to NAWQC was conducted in the draft final Parcel D FS. Mr. Maxwell indicated that the EPA NAWQC for the human consumption of fish may not have been evaluated in the Parcel D FS, and may need to be evaluated to complete the human health risk assessment.

Mr. Maxwell also stated that if infiltration/exfiltration along sanitary sewer lines affects groundwater flow patterns in Parcel D, the existence of such conditions should not be relied upon as a means of groundwater containment. Mr. Maxwell also questioned whether the Navy will be relying on seawall structures for containment of contaminant plumes near the shoreline. Mr. Maxwell also indicated that the Navy should evaluate groundwater data for hexachloroethane detections at several wells in Parcel D, including wells IR33MW61A and IR71MW03A (hexachloroethane has no MCL but has a tap water preliminary remediation goal).

Ms. Lauth stated that in groundwater areas that are above state TDS criterion of 3,000 milligrams per liter (mg/L) but below the federal TDS criterion of 10,000 mg/L, EPA may consider waiving federal TDS criteria if there are mitigating factors at the area that would preclude remediation. Mr. Maxwell indicated that regardless of the TDS concentrations, groundwater areas with contaminant plumes may need to be considered in the FS to comply with the RWQCB non-degradation policy.

Recommendations

The BCT members concurred upon the recommendations summarized in the table below. A detailed summary of the basis for these recommendations is presented in Attachment B.

RECOMMENDATIONS FOR PARCEL D GROUNDWATER AREAS

Include in FS Addendum	Conduct additional sampling	No further action		Further evaluation	
• IR09MW35A	• IR09MW35A	• IR08MW40A	• IR70MW12A	• IR33MW61A*	• IR22MW15A
• IR09PPY1	• IR09PPY1	• IR08MW42A	• IR09P040A	• IR09MW35A	• IR22MW16A
	• IR33MW61A	• IR08MW44A	• IR44MW08A	• IR09MW51F	• IR22MW20A
	• IR34MW01A	• IR09MW45F	• PA50MW05A	• IR22MW07A	• IR09MW44A
	• IR71MW03A	• IR09P041A	• IR36MW16A	• IR22MW08A	• IR09P043A
		• IR33MW116A	• IR67MW04A		• PA33MW37A
		• IR22MW20A	• IR70MW11A		

* Address benzene contamination in CAP

Areas recommended for additional sampling are proposed for two consecutive sampling rounds approximately 60 days apart. The Navy will notify the BCT of the timing of the field activities as soon as possible.

SCHEDULED MEETINGS

March 7, 10:00 to 3:00 — Parcel C groundwater evaluation meeting

March 16, 10:00 to 3:00 — Parcel C risk management response to comments meeting (tentative date pending receipt of comments from DTSC and the City by February 18)

ACTION ITEMS

Action items from this meeting are presented in the following table.

Action	Responsible Party	*Date Accomplished*
Parcel D. The Navy will contact RWQCB and EPA to clarify the Navy's interpretation of Parcel D Hydropunch groundwater data and associated monitoring well groundwater data.	Julie Crosby (Navy)	April 25, 2000
Parcel D. Evaluate precipitation data during February 1996 for a correlation between high rainfall and anomalously high chromium sample results at monitoring wells IR33MW61A and IR34MW01A.	Julie Crosby (Navy)	April 25, 2000
Parcel D. The Navy will contact RWQCB and EPA to present a summary of the groundwater yield at IR09MW51F (bedrock well).	Julie Crosby (Navy)	April 25, 2000
Parcel D. The Navy will contact RWQCB and EPA to clarify the Navy's evaluation of hexachloroethane detections at several Parcel D wells.	Julie Crosby (Navy)	April 25, 2000
Parcel C. The Navy will incorporate EPA comments for the Parcel C groundwater evaluation meeting. Specifically, the meeting will focus on the following: • Refining existing remedial unit boundaries where MCLs/HGALs are exceeded • Areas where MCLs/HGALs for metals, VOCs, SVOCs, pesticides, and PCBs are exceeded—no need to detail each specific chemical • Potential B-aquifer data gaps In addition, hard copy maps of areas that exceed MCLs/HGALs, TDS contours, and B-aquifer distribution will include well locations and names.	Julie Crosby (Navy)	March 7, 2000

ATTACHMENT A
LIST OF ATTENDEES

Name	Organization
Andy Piszkin	Navy
Dave DeMars	Navy
Jose Payne	Navy
Julie Crosby	Navy
Michael Pound	Navy
William Radzevich	Navy
John Corpos	Navy
Sheryl Lauth	EPA
Claire Trombadore	EPA
Chein Kao	DTSC
Chris Maxwell	RWQCB
Jason Brodersen	TtEMI
Raimi Quiton	TtEMI
Scott Wald	TtEMI
Doug Bielskis	TtEMI
Jean Michaels	TtEMI
Kim Huynh	TtEMI
Ian Austin	Dames & Moore
Virginia Lau	Dames & Moore
Don Bradshaw	Levine Fricke Recon

ATTACHMENT B

GROUNDWATER EVALUATION RECOMMENDATIONS
PARCEL D, HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site Number	Well where MCL/HGAL was exceeded	Chemical(s) of concern	Recommendations	Basis for Recommendations
IR-08	IR08MW40A	• Bis(2-ethylhexyl) phthalate	**EPA, RWQCB, and Navy:** No further action	• Isolated detection followed by three rounds with non-detect results (not shown on Table A-4) *(note: Detection was not shown on Figure 5B)* • No known source in area; attributed to laboratory contamination • Well located in area with TDS > 10,000 mg/L
	IR08MW42A	• Aroclor-1260	**EPA, RWQCB, and Navy:** No further action	• Detected concentrations were followed by four rounds with non-detect results • Well located in area with TDS > 10,000 mg/L • Source removal has occurred in area—additional characterization and/or source removal work is anticipated
	IR08MW44A	• Thallium	**EPA, RWQCB, and Navy:** No further action	• Isolated detection followed by two rounds with non-detect results
IR-09	IR09MW35A	• Chromium • Nickel • Bis(2-ethylhexyl) phthalate	**EPA, RWQCB, and Navy:** Evaluate chromium concentrations in FS addendum and conduct additional sampling for chromium RWQCB: Evaluate Nickel in FS addendum	• Chromium exceeded MCL in multiple sampling rounds • Detected chromium VI concentrations at well • Well located in area of hydraulic connection between A- and B-aquifers • TDS concentration at well (14,000 mg/L) is not consistent with surrounding groundwater • Nickel concentrations exceeding MCLs followed by four rounds with results below the MCL • Isolated bis(2-ethylhexyl)phthalate detection preceded by three rounds and followed by one round with non-detect results • Potential relationship of nickel concentrations to surrounding chromium concentrations.

GROUNDWATER EVALUATION RECOMMENDATIONS
PARCEL D, HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site Number	Well where MCL/HGAL was exceeded	Chemical(s) of concern	Recommendations	Basis for Recommendations
IR-09 (cont.)	IR09MW45F	• Antimony	**EPA, RWQCB, and Navy:** No further action	• Isolated detection followed by two rounds with non-detect results
	IR09MW51F	• Chromium • Trichloroethene • Methylene chloride	**EPA and RWQCB:** Conduct additional sampling	• Trichloroethene (TCE) and chromium exceeded MCLs in multiple sampling rounds • Well located in area of hydraulic connection between A-aquifer and bedrock water-bearing zone
			Navy: No further action (pending evaluation of well yield at IR09MW51F)	• Well completed within bedrock water-bearing zone • Decreasing TCE concentrations in recent sampling rounds • Bedrock water-bearing zone in Parcel A was de-designated as a drinking water source based on insufficient yield; similar conditions exist at Parcel D
	IR09PPY1	• Chromium	**EPA, RWQCB, and Navy:** Evaluate chromium concentrations in FS addendum and conduct additional sampling for chromium	• Chromium exceeded MCLs in multiple sampling rounds • Detected chromium VI concentrations at well • Well located in area with TDS concentration <3,000 mg/L
	IR09P041A	• Aluminum	**Navy:** No further action *Note: EPA and RWQCB were not presented aluminum data*	• Isolated detection followed by one round with non-detect results • Aluminum concentrations within acceptable risk range (i.e., less than tap water PRG)
	IR33MW116A	• Bis(2-ethylhexyl) phthalate	**EPA, RWQCB, and Navy:** No further action	• Isolated detection preceded by two rounds with non-detect results • No known source in area; attributed to laboratory contamination

ATTACHMENT B (continued)

GROUNDWATER EVALUATION RECOMMENDATIONS
PARCEL D, HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site Number	Well where MCL/HGAL was exceeded	Chemical(s) of concern	Recommendations	Basis for Recommendations
IR-22	IR22MW07A	• Arsenic • Lead	**EPA and RWQCB:** Further evaluation of data with respect to NAWQC and potential soil sources	• Well located in an area of tidal influence
			Navy: No further action	• Isolated detections preceded by two rounds with either non-detect results or results below drinking water standards • Well located in area with TDS concentrations >10,000 mg/L • Draft final FS for Parcel D evaluated data with respect to NAWQC; Navy agrees to conduct monitoring under RAMP
	IR22MW08A	• Lead	**EPA and RWQCB:** Further evaluation of data with respect to NAWQC and potential soil sources	• Well located in an area of tidal influence
			Navy: No further action	• Isolated detection followed by one round with non-detect results • Well located in area with TDS concentrations >10,000 mg/L • Draft final FS for Parcel D evaluated data with respect to NAWQC; Navy agrees to conduct monitoring under RAMP
	IR22MW15A	• Lead	**EPA and RWQCB:** Further evaluation of data with respect to NAWQC and potential soil sources	• Well located in an area of tidal influence
			Navy: No further action	• Isolated detection preceded by one round and followed by two rounds with non-detect results • Well located in area with TDS concentrations >10,000 mg/L • Draft final FS for Parcel D evaluated data with respect to NAWQC; Navy agrees to conduct monitoring under RAMP

ATTACHMENT B (continued)

GROUNDWATER EVALUATION RECOMMENDATIONS
PARCEL D, HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site Number	Well where MCL/HGAL was exceeded	Chemical(s) of concern	Recommendations	Basis for Recommendations
IR-22 (cont.)	IR22MW16A	• Arsenic • Lead	**EPA and RWQCB:** Further evaluation of data with respect to NAWQC and potential soil sources	• Well located in an area of tidal influence
			Navy: No further action	• Isolated arsenic detection preceded by two rounds with either non-detect results or results below drinking water standards • Low lead concentrations detected in two rounds (20.2 to 26.1 μg/L) • Well located in area with TDS concentrations >10,000 mg/L • Draft final FS for Parcel D evaluated data with respect to NAWQC; Navy agrees to conduct monitoring under RAMP
	IR22MW20A	• Chromium • Aluminum	**EPA, RWQCB, and Navy:** No further action for chromium Navy: No further action for aluminum *Note: EPA and RWQCB were not presented aluminum data*	• Isolated detections followed by two rounds with either non-detect results or results below the MCLs • No NAWQC for chemicals of concern • Chromium VI results from well were non-detect • Aluminum concentrations within acceptable risk range (i.e., less than tap water PRG)
IR-32	IR70MW12A	• Cadmium	**EPA, RWQCB, and Navy:** No further action	• Isolated detection preceded by two rounds with either non-detect results or results below drinking water standards • Well located in area with TDS concentrations >3,000 mg/L, but <10,000 mg/L

ATTACHMENT B (continued)

GROUNDWATER EVALUATION RECOMMENDATIONS
PARCEL D, HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site Number	Well where MCL/HGAL was exceeded	Chemical(s) of concern	Recommendations	Basis for Recommendations
IR-33 North	IR33MW61A	• Benzene • Chromium • Arsenic • Aluminum	**EPA, RWQCB, and Navy:** Conduct additional sampling for chromium; consider evaluating benzene concentrations in petroleum hydrocarbon corrective action plan Navy: No further action for aluminum *Note: EPA and RWQCB were not presented with aluminum data*	• Concentrations of chromium detected at well increased in consecutive rounds • Chromium VI results from adjacent well (PA50MW11A) were non-detect • Benzene concentrations associated with gasoline release from former USTs at Building 304 • Benzene concentrations decreasing in recent rounds • Isolated detection of arsenic followed by two rounds with either non-detect results or results below drinking water standards • Aluminum concentrations within acceptable risk range (i.e., less than tap water PRG)
IR-33 South	IR09MW44A	• Nickel	**RWQCB:** Further evaluation of nickel concentrations	• Potential relationship of nickel concentrations to surrounding chromium concentrations
			EPA and Navy: No further action	• Nickel concentrations exceeding MCLs followed by three rounds with results below the MCL • Well located in area with TDS concentrations >3,000 mg/L, but <10,000 mg/L
	IR09P040A	• Benzo(a)pyrene	**EPA, RWQCB, and Navy:** No further action	• Isolated detection followed by five rounds of either non-detect results or results below drinking water standards • Well located in area with TDS concentrations >3,000 mg/L, but <10,000 mg/L
	IR09P043A	• Nickel	**EPA, RWQCB, and Navy:** Further evaluation of nickel concentrations	• Nickel exceeded MCL in multiple rounds

ATTACHMENT B (continued)

GROUNDWATER EVALUATION RECOMMENDATIONS
PARCEL D, HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site Number	Well where MCL/HGAL was exceeded	Chemical(s) of concern	Recommendations	Basis for Recommendations
IR-33 South (cont.)	PA33MW37A	• Nickel • Lead	**RWQCB:** Further evaluation of nickel concentrations	• Potential relationship of nickel concentrations to surrounding chromium concentrations
			EPA and Navy: No further action	• Isolated nickel detection preceded by one round and followed by one round with results below the MCL • Isolated lead detection preceded by one round and followed by two rounds with either non-detect results or results below drinking water standards • Well located in area with TDS concentrations >3,000 mg/L, but <10,000 mg/L
IR-34	IR34MW01A	• Chromium • Aluminum	**EPA, RWQCB, and Navy:** Conduct additional sampling for chromium Navy: No further action for aluminum *Note: EPA and RWQCB were not presented with aluminum data*	• Increased chromium concentration in most recent sampling round • Well in area with TDS <3,000 mg/L • Aluminum concentrations within acceptable risk range (i.e., less than tap water PRG)
IR-44	IR44MW08A	• Cadmium	**EPA, RWQCB, and Navy:** No further action	• Isolated detection followed by two rounds with non-detect results • Well in area with TDS >3,000 mg/L, but <10,000 mg/L
IR-55	PA50MW05A	• Lead	**EPA, RWQCB, and Navy:** No further action	• Isolated detection followed by three rounds with non-detect results
IR-67	IR36MW16A	• Aluminum	**Navy:** No further action *Note: EPA and RWQCB were not presented with aluminum data*	• Isolated detection followed by three rounds with either non-detect results or results below MCL • Aluminum concentrations within acceptable risk range (i.e., less than tap water PRG)
	IR67MW04A	• Cadmium • Thallium	**EPA, RWQCB, and Navy:** No further action	• Isolated detection followed by two rounds with either non-detect results or results below HGALs

ATTACHMENT B (continued)

GROUNDWATER EVALUATION RECOMMENDATIONS
PARCEL D, HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site Number	Well where MCL/HGAL was exceeded	Chemical(s) of concern	Recommendations	Basis for Recommendations
IR-70	IR70MW11A	• Cadmium	**EPA, RWQCB, and Navy:** No further action	• Low cadmium concentrations detected in two sampling rounds (7.7 to 24.3 µg/L) • Well located in area with TDS >3,000 mg/L, but <10,000 mg/L
IR-71	IR71MW03A	• Tetrachloroethene • Trichloroethene • Carbon tetrachloride	**EPA, RWQCB, and Navy:** Conduct additional sampling for PCE and TCE	• Tetrachloroethene (PCE) and TCE exceeded MCLs in multiple sampling rounds • Isolated detection of carbon tetrachloride followed by two rounds with either non-detect results or results below MCL • Well in area with TDS >3,000 mg/L, but <10,000 mg/L

Notes:

EPA	U.S. Environmental Protection Agency
HGAL	Hunters Point groundwater ambient level
MCL	Maximum contaminant level
mg/L	Milligrams per liter
Navy	U.S. Department of the Navy
NAWQC	National Ambient Water Quality Criteria
PCE	Tetrachloroethene
PRG	Preliminary remediation goal
RWQCB	Regional Water Quality Control Board
TCE	Trichloroethene
TDS	Total dissolved solids
µg/L	Micrograms per liter
UST	Underground storage tank

PARCEL C GROUNDWATER EVALUATION
HUNTERS POINT SHIPYARD
MEETING MINUTES
March 7, 2000

These meeting minutes summarize the groundwater issues meeting for Parcel C of Hunters Point Shipyard (HPS). The meeting was held on March 7, 2000, at the San Francisco office of Tetra Tech EM, Inc. (TtEMI) and was attended by the Base Realignment and Closure (BRAC) Cleanup Team (BCT). A list of attendees is included at the end of these minutes. These meeting minutes discuss the key points, decisions, and action items agreed to at the meeting.

ANNOUNCEMENTS

Richard Mach, the BRAC Environmental Coordinator (BEC) for the Navy, announced that the agenda had been revised to include the Navy's proposed facility-wide approach for addressing groundwater data gaps. Mr. Mach explained that following the Navy's proposed approach would allow for the collection of data needed to make appropriate decisions in the feasibility studies (FS). Mr. Mach then invited each of the regulatory agency representatives to share their groundwater concerns with the group. Sheryl Lauth of the U.S. Environmental Protection Agency (EPA), Chein Kao and Eileen Hughes of the Department of Toxic Substances Control (DTSC), and Chris Maxwell of the Regional Water Quality Control Board (RWQCB) each shared their groundwater concerns.

Ms. Lauth stated that additional A-aquifer work is not required. She felt that, at Parcel C, it is not an issue of cleanup or no cleanup, rather an issue of how much cleanup. Collection of B-aquifer data is necessary. Based on the drinking water pathway, EPA would like 11 wells outside of the existing remedial units (RU) to be evaluated in the FS addendum, in addition to the existing RUs.

Mr. Maxwell is concerned with adequate characterization of the plumes, including identifying sources, extent, and concentrations. After plumes are characterized, one can then review receptors and pathways. Mr. Maxwell feels that plumes, not areas, should move forward into the FS. The FS should address the feasibility of and the extent of cleanup. In addition, Mr. Maxwell expressed concern for (1) deep soil contamination as a source to groundwater, (2) dense non-aqueous phase liquids (DNAPL) data gaps, (3) degradation of contaminants, (4) human consumption of fish pathway, and (5) yield and TDS data for the B-aquifer and the bedrock water bearing zone.

Mr. Kao and Ms. Hughes are concerned that the RUs were drawn based on only ecological data and the human health inhalation pathway. DTSC would like the RUs to be redrawn to include the drinking water pathway. In addition, DTSC indicated that the RUs should be drawn on a plume basis rather than on a well basis. Also, DTSC would like chromium VI issues in groundwater to be reevaluated.

Mr. Mach then outlined the Navy's proposed facility-wide approach for addressing groundwater data gaps. The Navy's approach is as follows:

- Update groundwater chemical data, including wet/dry season, TPH, MNA parameters, and TDS
- Update groundwater elevation data, including wet/dry season for each aquifer
- B-aquifer characterization
- A-/B-aquifer and A-aquifer/bedrock interactions

- Identify and correct outside groundwater influences (storm sewer and sanitary sewer lines)
- Update TDS data
- Evaluate well yield
- Evaluate seawall integrity and tidal exchange

Mr. Mach stated that the Navy's proposed approach would evaluate groundwater plumes and flow direction regardless of parcel boundaries. However, the results of the facility-wide assessment would be incorporated into the FS addenda for each parcel. Mr. Mach explained that the Navy would like to take an aggressive approach to accomplishing these tasks with minimal impact to the FFA schedule. To achieve this, he requested that the **BCT agree to weekly working meetings to develop a scope and Data Quality Objectives for a Field Sampling Plan and Quality Assurance Project Plan** in order to be in the field by early to mid-April.

Discussion ensued regarding the use of existing treatability study data, collection of soil gas data, municipal use of groundwater, and development of a schedule for the Navy's proposed approach.

Mr. Mach stated that **TtEMI should forward a strawman schedule and meeting minutes to him by Friday** and **Mr. Mach would forward both to the BCT on Monday**.

The remainder of the meeting was spent reviewing Parcel C groundwater data, as provided in the February 29, 2000 Parcel C data package and using the Geographic Information System (GIS). The BCT roughly identified areas surrounding the existing groundwater RUs that require further evaluation.

The following specific comments and concerns were raised by the RWQCB during the meeting:

- Do significant RI data gaps exist for DNAPLs at RU-4 and RU-6? Where are the contaminants migrating to and what soil remediation is proposed for the DNAPLs?

- Has there been agreement that the chromium at the site is related to serpentinite bedrock? Has the chromium in groundwater been speciated and have chromium VI plumes been identified?

- Will additional field activities be conducted to examine the yield of the bedrock aquifer?

- Is the Arochlor 1260 in groundwater at 25MW15A2 and lower detection in groundwater at 25MW15A1 part of the same plume?

- What is the source of the fluoride in wells 25MW19A and 25MW20A?

- Is Arochlor 1260 at 0.98 ppb, TCE at 86 ppb, and hexachloroethane at 8 ppb at monitoring well 25MW16A related to source areas in IR25 or other sources? Is monitoring well MW16A downgradient of 25MW11A? If contaminants in monitoring well 25MW16A are related to the IR25 source area, then where are the chlorinated degradation byproducts (DCE, DCA, TCA) found in source wells 15A1, 15A2, 18A, 19A and 44A in IR25?

- Discussion was conducted regarding the concentrations of solvents in deep soils at IR25, specifically PCE in soil removal area 25-1. Soil removal table only addresses the upper 10 feet of soil, and does not propose removal for TCE and PCE. What remedial actions will be taken for solvents in soil deeper than 10 feet?

- What is the source(s) of hexachloroethane (530 ppb) and pentachlorophenol (6,100 ppb) in 25MW11A? Was this the only well where these contaminants were detected (or sampled for)?

- What is the source of Arochlor 1260 (2.9 ppb) at 28MW171A (RU-3)?

- Is TCE near the MCL at 28MW200A (6 ppb) and 28MW298A (9 ppb) in the A-aquifer related to solvents in RU-4 or another source? "Source" well 28MW311A has 53 ppb of TCE.

- The Navy should evaluate the recommendation for benzo(a)pyrene in 28MW311A since benzo(a)pyrene was detected at 3 ppb in one round, but the next two rounds had a detection limits at 10 ppb.

- The Navy should evaluate the need to resample for carbon tetrachloride at well 28MW275F. This detection appears to be a degradation product associated with a plume of other chlorinated hydrocarbons.

- What is the source for Arochlor 1260 in RU-7 at 28MW129A (23 ppb)? No soil cleanup proposed for this area.

- What is the source(s) for TCE and carbon tetrachloride at wells 28MW300F, 28MW189F, and 28MW190F? Is this related to sources in RU-5, or another source?

- The recommendations table is missing well 28MW286A (5 ppb) for PCE; the well is located southeast of RU-5.

- Are Arochlor detections at 29MW48A in the groundwater related to single plume, or separate plumes and separate sources?

SCHEDULED MEETINGS

March 16, 9:00 to 3:00	Follow-on groundwater evaluation meeting
March 21, 10:00 to 4:00	BCT monthly meeting, FS addendum scoping discussion
March 23, 9:00 to 3:00	Parcel D risk management/Follow-on groundwater evaluation meeting
March 30, 11:00 to 4:00	Follow-on groundwater evaluation meeting
April 6, 10:00 to 3:00	Parcel C risk management review response to comments meeting

ACTION ITEMS

Action items from this meeting are presented in the following table.

Action	Responsible Party	Date Due/*Date Accomplished*
Parcel B, C, D, and E. The Navy will provide the BCT with a draft outline and schedule for the Navy's proposed basewide groundwater re-evaluation.	Julie Crosby (Navy)	March 13, 2000
Parcel C. The Navy will forward draft meeting minutes to the BCT on the March 7th meeting.	Julie Crosby (Navy)	March 13, 2000
Parcel C. The Navy will provide the BCT with revised groundwater remedial units based on an analysis of individual chemical plumes with respect to the drinking water pathway.	Julie Crosby (Navy)	March 16, 2000

Hunters Point Shipyard
Meeting Attendance Sheet

Topic: **Parcel C Groundwater Evaluation**

Date: **March 7, 2000**

Time: **10 am – 3 pm**

Location: **TtEMI Office**

Organization	Name	Phone Number	E-Mail Address
Navy	Richard Mach	619.532.0913	MachRG@efdsw.navfac.navy.mil
	Dave DeMars	619.532.0912	DeMarsDB@efdsw.navfac.navy.mil
	Jose Payne	619.532.0962	PayneJE@efdsw.navfac.navy.mil
	Julie Crosby	619.532.0932	CrosbyJA@efdsw.navfac.navy.mil
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	Michael Pound	619.532.2546	PoundMJ@efdsw.navfac.navy.mil
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DTSC	Chein Kao	510.540.8322	ckao@dtsc.ca.gov
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RWQCB	Chris Maxwell	510.622.2377	cm@rb2.swrcb.ca.gov
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Others *TAG/Envirometrix*	Norman Shopay	415.543.2000	norman@envirometrix.com

PARCELS C AND D GROUNDWATER EVALUATION
HUNTERS POINT SHIPYARD
MEETING MINUTES
March 16, 2000

These meeting minutes summarize the March 16, 2000 groundwater evaluation meeting for Parcels C and D of Hunters Point Shipyard (HPS). The meeting was held at the San Francisco office of Tetra Tech EM, Inc. (TtEMI) and was attended by the Base Realignment and Closure (BRAC) Cleanup Team (BCT). A list of attendees is included at the end of these minutes. These meeting minutes discuss the key points, decisions, and action items agreed to at the meeting.

ANNOUNCEMENTS

Richard Mach, the BRAC Environmental Coordinator (BEC) for the Navy, reviewed the agenda and the overall purpose for the meeting. Mr. Mach explained that the overall purpose of the meeting (and subsequent working meetings proposed for March 23 and March 30, 2000) is to determine groundwater data gaps at HPS, and that such data is needed to make appropriate decisions in the feasibility studies (FS). Mr. Mach indicated that the scope of the data gaps work is intended to be summarized in a field sampling plan (FSP).

The Department of Toxic Substances Control (DTSC) stated that while these meetings were held to provide regulatory agencies' input and consultation in helping the Navy produce a better work product, they should not be construed as a pre-approval of final deliverables.

PARCEL C GROUNDWATER EVALUATION

Julie Crosby, Remedial Project Manager (RPM) for the Navy, presented revised groundwater remedial units for Parcel C using the Geographic Information System (GIS). Ms. Crosby explained that the revised areas are based on potential chemical plumes, as suggested in the previous working meeting on March 7, 2000. The group first discussed revised remedial unit (RU) C1, which surrounds the former RU-2. Sheryl Lauth of the U.S. Environmental Protection Agency (EPA), Chein Kao and Eileen Hughes of DTSC, and Chris Maxwell of the Regional Water Quality Control Board (RWQCB) each shared their general and specific comments. The group then discussed revised RU-C2 (located around former RU-5), at which time agency representatives added further specific comments on the Navy proposal.

During a break from the meeting, the Navy and TtEMI convened to discuss the progress of the meeting. The Navy decided that a complete set of data quality objectives (DQO) is necessary to effectively determine the scope of the Parcel C groundwater data gaps. Since a complete set of DQOs had not yet been prepared, the Navy decided that a determination of the data gaps scope was not appropriate during the current meeting. Upon rejoining the meeting, the Navy changed the focus of the meeting to a general "brainstorming" session discussing agency concerns regarding Parcel C groundwater.

The following specific agency comments are documented in hand-written notes; however, these specific comments on the Parcel C groundwater evaluation were omitted from these meeting minutes for brevity. The key points of the Parcel C discussion are summarized as follows:

- ***BCT agreed to continue to work together to scope data gaps for Parcel C during a meeting on March 23rd (to include an evaluation of hydropunch and grab groundwater samples)***

- ***Complete summary of data quality objectives (DQO) for the data gaps work will be submitted to the BCT in 30 days (April 17, 2000)***
- ***Overall goal of data gaps scope is to provide information required for FS—Navy may collect additional data for remedial design and technology evaluations, as appropriate, but it will not be focus of data gaps work***
- ***Data gaps work may delay FS schedule (particularly if revised treatability study is necessary), effort will be made to not affect proposed plan/record of decision schedule—Navy to work on revising schedule to reflect data gaps needs***
- ***Plumes will be carried forward to FS, not individual wells***
- ***Parcel C data gaps work will address***
  - ***Re-sampling at existing A- and B-aquifer and bedrock zone wells***
  - ***Additional B-aquifer wells***
  - ***Vertical gradients between aquifers/water-bearing zones***
  - ***Well yield in bedrock water-bearing zone***
  - ***Bay mud as viable aquitard***
  - ***Outside groundwater influences (utility lines)***
- ***Data gaps work may be conducted in phased approach (for example, Phase I may include hydrology assessment and re-sampling of existing wells; Phase II may include sampling at Phase I wells and sampling at additional wells based on Phase I results)***
- ***Seasonal effects should be considered—wet vs. dry season; post-El Nino effects on groundwater elevation, chemical concentrations, flow direction***
- ***Facility-wide B-aquifer distribution map will be provided in final GW report for review and comment***
- ***Agencies need time to review SOPs for new field sampling methods (diffusion samplers, micropurging)***
- ***DTSC indicated that well survey should be conducted as soon as possible***
- ***Data gaps work should address potential DNAPL at IR-25 and IR-28 in Parcel C***
- ***RWQCB/DTSC indicated that hydropunch data needs to be reviewed to refine existing plumes***

PARCEL D GROUNDWATER EVALUATION

Ms. Crosby presented the Navy's proposal for re-sampling Parcel D groundwater wells. A one-page outline of the Navy's proposal was provided to the BCT. Based on agency comments during the meeting, the table was revised and will be addressed with the DQOs. The key points of the Parcel D discussion are summarized as follows:

- ***Complete summary of data quality objectives (DQO) for the data gaps work will be submitted to the BCT in 30 days***
- ***Parcel D data gaps work will address***
  - ***Re-sampling at existing A-aquifer and bedrock zone wells (see attached table)***
  - ***Additional B-aquifer wells***
  - ***Vertical gradients between aquifers/water-bearing zones***
  - ***Well yield in bedrock water-bearing zone***
  - ***Bay mud as viable aquitard***
  - ***Outside groundwater influences (utility lines)***
- ***Data gaps work may be conducted in phased approach***
- ***Seasonal effects should be considered— wet vs. dry season; post-El Nino effects on groundwater elevation, chemical concentrations, flow direction***

- ***FS schedule for Parcel D will be affected if sampling to account for seasonal variations is necessary—BCT to discuss further***
- ***Facility-wide B-aquifer distribution map will be provided in final GW report for review and comment***
- ***EPA requested that scope of B-aquifer wells be in DQO package***
- ***EPA suggested that Navy consider re-sampling at IR-22 wells (not currently proposed)***
- ***Meeting minutes from February 7, 2000 meeting on Parcel D groundwater will be finalized pending receipt of comments from BCT***

SCHEDULED MEETINGS

March 21, 10:00 to 4:00	BCT monthly meeting, FS addendum scoping discussion
March 23, 9:30 to 4:00	Parcel D risk management/Parcel C groundwater evaluation meeting
March 30, 11:00 to 4:00	Parcel C groundwater evaluation meeting (tentative)
April 6, 10:00 to 3:00	Parcel C risk management review response to comments meeting

ACTION ITEMS

Action items from this meeting are presented in the following table.

Action	Responsible Party	Date Due/*Date Accomplished*
Parcel B, C, D, and E. The Navy will provide the BCT with a summary of DQOs for the Navy's proposed groundwater data gaps investigation.	Julie Crosby (Navy)	April 17, 2000
Parcel B, C, D, and E. The Navy will provide the BCT with a proposed schedule for the proposed groundwater data gaps investigation.	Julie Crosby (Navy)	April 25, 2000
Parcel C. The Navy will provide hydropunch data to BCT for review of Parcel C groundwater.	Julie Crosby (Navy)	*March 21, 2000*
Basewide. The Navy will provide supporting information regarding the current interpretation of the Bay Mud aquitard and relationship with A- and B- aquifers.	Julie Crosby (Navy)	To be included in next groundwater evaluation report – date to be determined

Hunters Point Shipyard
Meeting Attendance Sheet

Topic: **Parcels C and D Groundwater Evaluation**

Date: **March 16, 2000**

Time: **9:30 a.m. – 3 p.m.**

Location: **TtEMI Office**

Organization	Name	Phone Number	E-Mail Address
Navy	Richard Mach	619.532.0913	MachRG@efdsw.navfac.navy.mil
	Dave DeMars	619.532.0912	DeMarsDB@efdsw.navfac.navy.mil
	Jose Payne	619.532.0962	PayneJE@efdsw.navfac.navy.mil
	Julie Crosby	619.532.0932	CrosbyJA@efdsw.navfac.navy.mil
	John Corpos	650.244.2578	CorposJA@efawest.navfac.navy.mil
	Michael Pound	619.532.2546	PoundMJ@efdsw.navfac.navy.mil
U.S. EPA	Sheryl Lauth	415.744.2387	Lauth.sheryl@epamail.epa.gov
	Claire Trombadore	415.744.2409	Trombadore.Claire@epamail.epa.gov
DTSC	Chein Kao	510.540.8322	ckao@dtsc.ca.gov
	Eileen Hughes	510.540.3748	ehughes@dtsc.ca.gov
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IT Corporation *RAC contractor*	Jim Robbins	925.288.2313	JRobbins@theitgroup.com

PARCEL C GROUNDWATER EVALUATION MEETING
HUNTERS POINT SHIPYARD
MEETING MINUTES
March 23, 2000

These meeting minutes summarize the Hunters Point Shipyard (HPS) Parcel C groundwater evaluation meeting held from 1300-1500 on March 23, 2000, at the San Francisco office of Tetra Tech EM Inc. (TtEMI). These minutes include key points, decisions, and action items agreed upon at the meeting. A list of meeting attendees is included as Attachment A to these minutes.

ANNOUNCEMENTS

Richard Mach, the Base Realignment and Closure (BRAC) Environmental Coordinator (BEC) for the Navy, reviewed the agenda and the overall purpose for the meeting. Mr. Mach explained that the overall purpose of the meeting is to follow-on with discussions from previous working meetings on March 7, 2000 and March 16, 2000 regarding groundwater data gaps at Parcel C. Mr. Mach indicated that a primary objective of the meeting is to review hydropunch and grab groundwater sampling data to assist in identifying groundwater data gaps at Parcel C.

PARCEL C GROUNDWATER EVALUATION

Julie Crosby, Remedial Project Manager (RPM) for the Navy, reviewed the information provided for BRAC Cleanup Team (BCT) review during the monthly BCT meeting on March 21, 2000. This information included the following:

- **Table 1—Hydropunch Groundwater Sample Results that Exceed Screening Criteria, Parcel C, Hunters Point Shipyard, San Francisco, California:** Five-page table summarizing results that exceed either a State or Federal maximum contaminant level (MCL) or a Hunters Point groundwater ambient level (HGAL). Note that upon subsequent review of the tables, the Navy found several typographical errors in Table 1; therefore, the Navy is issuing a revised Table 1 to reflect the following corrections (Attachment B to these minutes):
  - Table 1, page 4: barium result at boring IR49B025 is 1,340 micrograms per liter (μg/L)
  - Table 1, all pages: results are reported to a maximum of three significant figures

- **Table 2—Grab Groundwater Sample Results that Exceed Screening Criteria, Parcel C, Hunters Point Shipyard, San Francisco, California:** Four-page table summarizing results that exceed either a State or Federal MCL or an HGAL. Note that upon subsequent review of the tables, the Navy found several typographical errors in Table 2; therefore, the Navy is issuing a revised Table 2 to reflect the following corrections (Attachment C to these minutes):
  - Table 2, page 1: antimony result at boring IR28B089 is 17.8 μg/L
  - Table 2, page 3: IR-29 station with benzene result is boring IR29MW72F
  - Table 2, all pages: results are reported to a maximum of three significant figures

- **Parcel C Groundwater Remedial Units—Navy Recommendations:** 11”x17” figure depicting the revised remedial units and groundwater monitoring wells proposed for re-sampling by the Navy (as discussed during the March 16, 2000 meeting)

- **Parcel C Grab and Hydropunch Sample Locations:** Two, 11”x17” figures depicting (1) all groundwater monitoring wells (with station IDs) and all grab and hydropunch sample locations (without station IDs), and (2) all groundwater monitoring wells (without station IDs) and all grab and hydropunch sample locations (with station IDs)

- **Key to Hydropunch/Grab Sample Locations, Parcel C, Hunters Point Shipyard, San Francisco, California:** One-page table summarizing estimated distances from hydropunch and grab sample locations (as listed in Tables 1 and 2) to the nearest groundwater monitoring well

Ms. Crosby presented revised groundwater remedial units (based on drinking water pathway) and the grab and hydropunch sample locations for Parcel C using the Geographic Information System (GIS). Ms. Crosby explained that the wells proposed for re-sampling by the Navy have not been revised to reflect BCT comments from the March 16, 2000 meeting. Ms. Crosby indicated that the Navy’s sampling plan for existing Parcel C wells would be presented in the data quality objectives (DQO) submittal (currently scheduled for April 17, 2000).

The group then discussed hydropunch and grab groundwater results in the vicinity of revised remedial units (RU)-C1, RU-C2, RU-C4, RU-C5, and RU-C7. Hydropunch and grab samples were only considered if they were greater than 100 feet from a well. If a well was located within 100 feet, the analyses from that well was used. Sheryl Lauth of the U.S. Environmental Protection Agency (EPA), Chein Kao and Eileen Hughes of the Department of Toxic Substances Control (DTSC), and Chris Maxwell of the Regional Water Quality Control Board (RWQCB) each shared their specific comments. The specific agency comments are documented in hand-written notes; however, these specific comments were omitted from these meeting minutes for brevity. The key points of the discussion are summarized as follows:

- ***Several areas of potential concern around revised RU-C1 were identified based on hydropunch and grab groundwater results as follows:***
  - ***Antimony detection at boring IR28B089 (located northeast of RU-C1) appears anomalous—note: upon verification, Navy determined that the reported antimony concentration in Table 2 was a typographical error, and the correct antimony concentration was 17.8 mg/L; a revised Table 2 is included as an attachment to these minutes***
  - ***Volatile organic compound (VOC) detections at boring IR28B101 (located northeast of RU-C1) may warrant further evaluation based on drinking water pathway***
  - ***Volatile organic compound (VOC) detections at boring IR28B108 (located northwest of RU-C1) may warrant further evaluation based on drinking water pathway***
  - ***Benzo(a)pyrene detection at boring IR28B141, and benzene and 1,4-dichlorobenzene detections at boring IR28B164 may warrant further evaluation/investigation (for example, evaluate potential petroleum hydrocarbon sources and/or install additional borings/wells)***
- ***An area of potential concern near RU-C2 was identified based on hydropunch and grab groundwater results as follows: VOC detections at borings IR58B010 and IR58B011 (located north of RU-C2) may warrant further evaluation based on drinking water pathway***
- ***Benzene detections at boring IR30B028 and nearby bedrock-zone well IR29MW72F (both located west of RU-C7) may warrant further evaluation based on drinking water pathway***

Mr. Mach reviewed and summarized the general conclusions of the group discussion. Mr. Mach also clarified that, although the revised groundwater remedial units are being extended during the groundwater reevaluation, the overall intent of the reevaluation process is to identify areas for data refinement. Mr. Mach stated that, based on the results of additional data evaluation, the remedial units may be revised to reflect any additional data. The BCT concurred with Mr. Mach's clarification.

The group then discussed other Parcel C groundwater data gaps. The key points of this discussion are summarized as follows:

- ***The extent of revised RU-C5 needs to be reevaluated considering the following points:***
  - ***Additional characterization is necessary in the vicinity of RU-C5***
  - ***Screening samples may be used in determining necessity and/or location of additional wells surrounding RU-C5***
  - ***Potential impacts to Parcel B groundwater will need to be addressed based on results of additional characterization***
  - ***RU-C5 boundary should be extended into IR-06, and possibly, IR-10 and IR-24) to capture VOC detections that exceed MCLs***
  - ***A qualitative review of the soil gas data from the Parcel C treatability study may be useful in a preliminary evaluation of RU-C5—however, due to laboratory quality assurance concerns expressed by EPA, the data may not be used in a formal evaluation***
- ***The RU-C2 boundary may require further evaluation and/or investigation to better determine the distribution of the chemicals of concern, and the hydrogeologic interaction between the different water-bearing units in the vicinity***

The meeting concluded with the discussion of several miscellaneous items as summarized below:

- ***RWQCB concerns regarding Parcel C groundwater need to be documented in meeting minutes—note: meeting minutes from March 7, 2000 meeting were subsequently revised to include complete summary of RWQCB concerns***
- ***RWQCB stated that the schedule for submitting a petroleum hydrocarbon corrective action plan (CAP) needs to be clarified—note: the CAP is not part of the Federal Facility Agreement schedule, and the Navy currently proposes a facility-wide CAP***
- ***The Navy will not hold any more groundwater evaluation meetings with the BCT until after the groundwater DQO submittal is reviewed by the BCT***
- ***The DQO submittal will focus on phase I sampling activities at Parcels C and D (for example, re-sampling existing wells and installing B-aquifer wells)—potential phase II activities may be referenced but will not be discussed in detail***
- ***The DQO submittal is scheduled to be submitted to the BCT on April 17, 2000—the Navy will notify the BCT of any potential delays for the DQO submittal***
- ***DTSC requested that the DQO submittal reference the proposed analytical methods, not merely the chemicals of concern***
- ***The Navy is currently assessing the condition of groundwater monitoring wells throughout HPS—the results of the assessment will assist the Navy in identifying wells that may require re-development prior to further sampling***
- ***Future characterization activities around RU-C5 will be adequately coordinated with the continued Parcel B Remedial Action***
- ***The BCT will need to discuss the appropriate means of documenting the results of the groundwater reevaluation at Parcels C and D***
- ***Groundwater evaluation meetings for Parcel E will be conducted at an appropriate time, following the groundwater reevaluation at Parcels C and D***

SCHEDULED MEETINGS

March 30, 11:00 to 4:00 Parcel B Remedial Action meeting

April 6, 10:00 to 3:00 Parcel C risk management review response to comments meeting

ACTION ITEMS

Action items from this meeting are presented in the following table.

Action	Responsible Party	Date Due/*Date Accomplished*
Parcel B, C, D, and E. The Navy will provide the BCT with a summary of DQOs for the Navy's proposed groundwater data gaps investigation.	Julie Crosby (Navy)	April 17, 2000
Parcel B, C, D, and E. The Navy will provide the BCT with a proposed schedule for the proposed groundwater data gaps investigation.	Julie Crosby (Navy)	April 18, 2000

ATTACHMENT A:

Hunters Point Shipyard
Meeting Attendance Sheet

Topic: **Parcels C Groundwater Evaluation**

Date: **March 23, 2000**

Time: **1:00 p.m. – 3 p.m.**

Location: **TtEMI Office**

Organization	Name	Phone Number	E-Mail Address
Navy	Richard Mach	619.532.0913	MachRG@efdsw.navfac.navy.mil
	Dave DeMars	619.532.0912	DeMarsDB@efdsw.navfac.navy.mil
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	Martin Offenhauer	619.532.0931	OffenhauerMB@efdsw.navfac.navy.mil
U.S. EPA	Sheryl Lauth	415.744.2387	Lauth.sheryl@epamail.epa.gov
DTSC	Chein Kao	510.540.8322	ckao@dtsc.ca.gov
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RWQCB	Chris Maxwell	510.622.2377	cm@rb2.swrcb.ca.gov
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TABLE 1

HYDROPUNCH GROUNDWATER SAMPLE RESULTS THAT EXCEED SCREENING CRITERIA
PARCEL C
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Results (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]
IR-28	IR28B084	1,1-Dichloroethane	9	--	5	--	810
	IR28B084	cis-1,2-Dichloroethene	75	70	6	--	61
	IR28B084	Vinyl chloride	320	2	0.5	--	0.02
	IR28B086	cis-1,2-Dichloroethene	5,500	70	6	--	61
	IR28B086	Trichloroethene	120	5	5	--	1.6
	IR28B086	Vinyl chloride	760	2	0.5	--	0.02
	IR28B090	Antimony	6.4[e]	6	6	43.26	15
	IR28B090	Vinyl chloride	190	2	0.5	--	0.02
	IR28B092	cis-1,2-Dichloroethene	2,300	70	6	--	61
	IR28B092	Tetrachloroethene	70	5	5	--	1.1
	IR28B092	Vinyl chloride	640	2	0.5	--	0.02
	IR28B094	Antimony	8.5[e]	6	6	43.26	15
	IR28B094	Tetrachloroethene	12	5	5	--	1.1
	IR28B094	Trichloroethene	21	5	5	--	1.6
	IR28B094	Vinyl chloride	140	2	0.5	--	0.02
	IR28B101	cis-1,2-Dichloroethene	8	70	6	--	61
	IR28B101	Vinyl chloride	2	2	0.5	--	0.02
	IR28B105	cis-1,2-Dichloroethene	36	70	6	--	61
	IR28B105	Tetrachloroethene	27	5	5	--	1.1
	IR28B105	Trichloroethene	16	5	5	--	1.6
	IR28B105	Vinyl chloride	8	2	0.5	--	0.02

ATTACHMENT B (Continued)

TABLE 1 (Continued)
HYDROPUNCH GROUNDWATER SAMPLE RESULTS THAT EXCEED SCREENING CRITERIA
PARCEL C
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Results (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]
IR-28 (cont.)	IR28B106	cis-1,2-Dichloroethene	32	70	6	--	61
	IR28B106	Tetrachloroethene	39	5	5	--	1.1
	IR28B106	Trichloroethene	20	5	5	--	1.6
	IR28B107	cis-1,2-Dichloroethene	1,000	70	6	--	61
	IR28B107	trans-1,2-Dichloroethene	210	100	10	--	120
	IR28B107	Vinyl chloride	17	2	0.5	--	0.02
	IR28B108	cis-1,2-Dichloroethene	15	70	6	--	61
	IR28B108	Vinyl chloride	120	2	0.5	--	0.02
	IR28B112	cis-1,2-Dichloroethene	1,300	70	6	--	61
	IR28B112	Vinyl chloride	160	2	0.5	--	0.02
	IR28B114	cis-1,2-Dichloroethene	560	70	6	--	61
	IR28B114	Trichloroethene	7	5	5	--	1.6
	IR28B114	Vinyl chloride	170	2	0.5	--	0.02
	IR28B115	Benzene	5	5	1	--	0.41
	IR28B115	cis-1,2-Dichloroethene	25	70	6	--	61
	IR28B115	Vinyl chloride	4	2	0.5	--	0.02
	IR28B120	cis-1,2-Dichloroethene	8	70	6	--	61
	IR28B120	Vinyl chloride	4	2	0.5	--	0.02
	IR28B121	cis-1,2-Dichloroethene	86	70	6	--	61
	IR28B121	Trichloroethene	240	5	5	--	1.6
	IR28B128A	Benzene	12	5	1	--	0.41

ATTACHMENT B (Continued)

TABLE 1 (Continued)
HYDROPUNCH GROUNDWATER SAMPLE RESULTS THAT EXCEED SCREENING CRITERIA
PARCEL C
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Results (μg/L)	EPA Primary MCL (μg/L)[a]	California Primary MCL (μg/L)[b]	HGAL (μg/L)[c]	EPA Region 9 Tap Water PRG (μg/L)[d]
IR-28 (cont.)	IR28B128A	cis-1,2-Dichloroethene	310	70	6	--	61
	IR28B128A	trans-1,2-Dichloroethene	15	100	10	--	120
	IR28B128A	Trichloroethene	99	5	5	--	1.6
	IR28B128A	Vinyl chloride	70	2	0.5	--	0.02
	IR28B133	cis-1,2-Dichloroethene	17	70	6	--	61
	IR28B133	Tetrachloroethene	8	5	5	--	1.1
	IR28B133	Trichloroethene	7	5	5	--	1.6
	IR28B133	Vinyl chloride	5	2	0.5	--	0.02
	IR28B141	Antimony	12.9[e]	6	6	43.26	15
	IR28B141	Benzo(a)pyrene	1	0.2	0.2	--	0.0092 (0.0015[f])
	IR28B164	1,4-Dichlorobenzene	30	75	5	--	0.50
	IR28B164	Benzene	2	5	1	--	0.41
	IR28B179	Carbon tetrachloride	6	5	0.5	--	0.17
	IR28B195	Antimony	10[e]	6	6	43.26	15
	IR28B199	cis-1,2-Dichloroethene	10	70	6	--	61
	IR28B199	Vinyl chloride	18	2	0.5	--	0.02
	IR28B207	Vinyl chloride	22	2	0.5	--	0.02
	IR28B209	cis-1,2-Dichloroethene	8	70	6	--	61
	IR28B209	Trichloroethene	36	5	5	--	1.6
	IR28B209	Vinyl chloride	0.8	2	0.5	--	0.02
	IR28B258	cis-1,2-Dichloroethene	110	70	6	--	61

ATTACHMENT B (Continued)

TABLE 1 (Continued)
HYDROPUNCH GROUNDWATER SAMPLE RESULTS THAT EXCEED SCREENING CRITERIA
PARCEL C
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Results (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]
IR-28 (cont.)	IR28B258	Vinyl chloride	140	2	0.5	--	0.02
	IR28B264	Benzene	8	5	1	--	0.41
	IR28B264	cis-1,2-Dichloroethene	39	70	6	--	61
	IR28B264	Vinyl chloride	120	2	0.5	--	0.02
	IR28B265	cis-1,2-Dichloroethene	92	70	6	--	61
	IR28B265	Vinyl chloride	38	2	0.5	--	0.02
	IR28B266	Trichloroethene	17	5	5	--	1.6
	IR28B267	Benzene	6	5	1	--	0.41
	IR28B267	cis-1,2-Dichloroethene	7	70	6	--	61
	IR28B267	Vinyl chloride	22	2	0.5	--	0.02
	IR28B279	1,2-Dichlorobenzene	1,200	600	600	--	370
	IR28B279	1,4-Dichlorobenzene	3,800	75	5	--	0.50
	IR28B279	Benzene	190	5	1	--	0.41
	IR28B282	Tetrachloroethene	36	5	5	--	1.1
	IR28B282	Trichloroethene	6	5	5	--	1.6
	IR28MW127A	cis-1,2-Dichloroethene	210	70	6	--	61
	IR28MW127A	trans-1,2-Dichloroethene	40	100	10	--	120
	IR28MW275F	cis-1,2-Dichloroethene	9	70	6	--	61
	IR28MW275F	Trichloroethene	130	5	5	--	1.6
	IR49B025	Antimony	7.1[e]	6	6	43.26	15
	IR49B025	Barium	1,340	2,000	1,000	504.2	2,600
	IR49B025	Thallium	3.5[e]	2	2	12.97	--
IR-29	IR49B015	Antimony	9.7[e]	6	6	43.26	15

TABLE 1 (Continued)
HYDROPUNCH GROUNDWATER SAMPLE RESULTS THAT EXCEED SCREENING CRITERIA
PARCEL C
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Results (μg/L)	EPA Primary MCL (μg/L)[a]	California Primary MCL (μg/L)[b]	HGAL (μg/L)[c]	EPA Region 9 Tap Water PRG (μg/L)[d]
	IR49B016A	Antimony	9.2[e]	6	6	43.26	15
	IR49B016A	Thallium	3.1[e]	2	2	12.97	--
	IR50B017	Antimony	17.7[e]	6	6	43.26	15
	IR50B017	Cadmium	7.4	5	5	5.04	18
IR-58	IR58B010	1,4-Dichlorobenzene	9	75	5	--	0.50
	IR58B010	Vinyl chloride	0.7	2	0.5	--	0.02
	IR58B028	1,4-Dichlorobenzene	77	75	5	--	0.50
	IR58B028	cis-1,2-Dichloroethene	370	70	6	--	61
	IR58B028	Vinyl chloride	370	2	0.5	--	0.02
	IR58MW31A	Tetrachloroethene	10	5	5	--	1.1

Notes: HydroPunch groundwater samples are not considered representative of Parcel C groundwater; data are presented for informational purposes only.

μg/L Microgram per liter
EPA U.S. Environmental Protection Agency
MCL Maximum contaminant level
HGAL Hunters Point groundwater ambient level
PRG Preliminary remediation goal
-- Not available
a EPA Office of Ground Water and Drinking Water. 1999. "Current Drinking Water Standards." Accessed on November 17, 1999. On-Line Address: http://www.epa.gov/OGWDW/wot/appa.html.
b California Department of Health Services. 1999. "Drinking Water Standards, Action Levels, and Unregulated Chemicals Requiring Monitoring." Accessed on November 17, 1999. On-Line Address: http://www.dhs.cahwnet.gov/org/ps/ddwem/chemicals/mcl/mclindex.htm.
c PRC Environmental Management, Inc. 1996. "Estimation of Hunters Point Shipyard Groundwater Ambient Levels Technical Memorandum." September 16.
d EPA. 1999b. "Region 9 Preliminary Remediation Goals 1999." October 1. PRGs are presented for informational purposes.
e The concentration exceeded the most stringent MCL but was less than the HGAL.
f California-modified PRG.

ATTACHMENT C:

TABLE 2

RESULTS FOR GRAB GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Results (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]
IR-25	IR25B012	Tetrachloroethene	37	5	5	--	1.1
	IR25B012	Thallium	2.51[e]	2	2	12.97	--
	IR25B012	Trichloroethene	14	5	5	--	1.6
	IR25B012	Trichloroethene	14	5	5	--	1.6
	IR25B012	Vinyl chloride	310	2	0.5	--	0.02
	IR25B013	Tetrachloroethene	59,000	5	5	--	1.1
	IR25B013	Thallium	2.73[e]	2	2	12.97	--
	IR25B013	Trichloroethene	12,000	5	5	--	1.6
IR-28	IR28B085	Antimony	12.7[e]	6	6	43.26	15
	IR28B085	Trichloroethene	220	5	5	--	1.6
	IR28B085	Vinyl chloride	82	2	0.5	--	0.02
	IR28B088	Antimony	16.8[e]	6	6	43.26	15
	IR28B089	Antimony	17.8[e]	6	6	43.26	15
	IR28B091	Antimony	11.8[e]	6	6	43.26	15
	IR28B091	Trichloroethene	23	5	5	--	1.6
	IR28B091	Vinyl chloride	250	2	0.5	--	0.02
	IR28B093	Antimony	13.6[e]	6	6	43.26	15
	IR28B093	Trichloroethene	18	5	5	--	1.6
	IR28B093	Vinyl chloride	170	2	0.5	--	0.02
	IR28B095	Antimony	8.3[e]	6	6	43.26	15
	IR28B095	Tetrachloroethene	11	5	5	--	1.1
	IR28B095	Trichloroethene	10	5	5	--	1.6

TABLE 2 (Continued)
RESULTS FOR GRAB GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Results (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]
IR-28 (cont.)	IR28B096	Barium	1,050	2,000	1,000	504.2	2,600
	IR28B098	Benzene	12	5	1	--	0.41
	IR28B098	Vinyl chloride	8	2	0.5	--	0.02
	IR28B113	Benzene	36	5	1	--	0.41
	IR28B113	cis-1,2-Dichloroethene	910	70	6	--	61
	IR28B113	Vinyl chloride	300	2	0.5	--	0.02
	IR28B174	Carbon tetrachloride	29	5	0.5	--	0.17
	IR28B176	Trichloroethene	13	5	5	--	1.6
	IR28B180	Carbon tetrachloride	30	5	0.5	--	0.17
	IR28B180	Trichloroethene	16	5	5	--	1.6
	IR28B186	1,2-Dichloroethane	0.9	5	0.5	--	0.12
	IR28B186	cis-1,2-Dichloroethene	14	70	6	--	61
	IR28B186	Vinyl chloride	11	2	0.5	--	0.02
	IR28B196	Antimony	6.5[e]	6	6	43.26	15
	IR28B196	Nickel	150	--	100	96.48	730
	IR28B196	Thallium	5.4[e]	2	2	12.97	--
	IR28B204	cis-1,2-Dichloroethene	7,700	70	6	--	61
	IR28B204	Tetrachloroethene	1,800	5	5	--	1.1
	IR28B204	Trichloroethene	6,700	5	5	--	1.6
	IR28B204	Vinyl chloride	600	2	0.5	--	0.02
	IR28B205	Trichloroethene	44,000	5	5	--	1.6
	IR28B210	Trichloroethene	11	5	5	--	1.6
IR-28 (cont.)	IR28B226	Trichloroethene	9	5	5	--	1.6

ATTACHMENT C (Continued)

TABLE 2 (Continued)
RESULTS FOR GRAB GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Results (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]
	IR28B237	Trichloroethene	31	5	5	--	1.6
	IR28B254	cis-1,2-Dichloroethene	100	70	6	--	61
	IR28B254	trans-1,2-Dichloroethene	16	100	10	--	120
	IR28B254	trans-1,2-Dichloroethene	16	100	10	--	120
	IR28B254	Trichloroethene	8	5	5	--	1.6
	IR28B254	Vinyl chloride	230	2	0.5	--	0.02
	IR28B261	Carbon tetrachloride	6	5	0.5	--	0.17
	IR28B261	Trichloroethene	50	5	5	--	1.6
	IR28B278	Carbon tetrachloride	0.9	5	0.5	--	0.17
	IR28B280	1,4-Dichlorobenzene	410	75	5	--	0.50
	IR28B280	Benzene	17	5	1	--	0.41
IR-29	IR29B046	Heptachlor epoxide	0.01	0.2	0.01	--	0.0074
	IR29MW72F	Benzene	5	5	1	--	0.41
	IR49B014	Antimony	9.5[e]	6	6	43.26	15
IR-30	IR30B028	Benzene	2	5	1	--	0.41
IR-58	IR58B011	Trichloroethene	14	5	5	--	1.6

TABLE 2 (Continued)
RESULTS FOR GRAB GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Notes: Grab groundwater samples are not considered representative of Parcel C groundwater; data are presented for informational purposes only.

µg/L	Microgram per liter
EPA	U.S. Environmental Protection Agency
MCL	Maximum contaminant level
HGAL	Hunters Point groundwater ambient level
PRG	Preliminary remediation goal
--	Not available
a	EPA Office of Ground Water and Drinking Water. 1999. "Current Drinking Water Standards." Accessed on November 17, 1999. On-Line Address: http://www.epa.gov/OGWDW/wot/appa.html.
b	California Department of Health Services. 1999. "Drinking Water Standards, Action Levels, and Unregulated Chemicals Requiring Monitoring." Accessed on November 17, 1999. On-Line Address: http://www.dhs.cahwnet.gov/org/ps/ddwem/chemicals/mcl/mclindex.html.
c	PRC Environmental Management, Inc. 1996. "Estimation of Hunters Point Shipyard Groundwater Ambient Levels Technical Memorandum. September16.
d	EPA. 1999b. "Region IX Preliminary Remediation Goals 1999." October 1. PRGs are presented for informational purposes only.
e	The concentration exceeded the most stringent MCL but was less than the HGAL.

GROUNDWATER ISSUES MEETING:
PARCEL D, HUNTERS POINT SHIPYARD, SAN FRANCISCO
FEBRUARY 7, 2000

LIST OF TABLES

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Notes

Tables modified from Appendix A of *Draft Final Technical Memorandum, Parcel D A-Aquifer Groundwater Beneficial Use Evaluation, Hunters Point Shipyard, San Francisco, California* (dated November 24, 1999).

Tables A-2 and A-3 from above-referenced document are not included for this data presentation.

TABLE A-1

SUMMARY OF MONITORING WELL GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]	Number of Sampling Events Exceeding Criteria[e]	Number of Sampling Events[f]
IR-08	IR08MW37A	Antimony	19.8	6	6	43.26	15	0	4
	IR08MW39A	Antimony	34.2	6	6	43.26	15	0	4
	IR08MW40A	Antimony	39.5	6	6	43.26	15	0	4
	IR08MW40A	Bis(2-ethylhexyl)phthalate	15	6	4	--	4.8	1 (1)[g]	2
	IR08MW41A	Antimony	37.7	6	6	43.26	15	0	4
	IR08MW42A	Antimony	18.8	6	6	43.26	15	0	2
	IR08MW42A	**Aroclor-1260**	**4.4**	**0.5**[j]	**0.5**[j]	**--**	**0.034**	**2 (2)**[g]	**6**
	IR08MW44A	Thallium	14.1	2	2	12.97	--	1	3
IR-09	IR09MW35A	Antimony	18.3	6	6	43.26	15	0	5
	IR09MW35A	Bis(2-ethylhexyl)phthalate	39	6	4	--	4.8	1 (2)[g]	5
	IR09MW35A	**Chromium**	**121**	**100**	**50**	**15.66**	**--**	**9**	**9**
	IR09MW35A	**Nickel**	**130**	**--**	**100**	**96.48**	**730**	**5**	**9**
	IR09MW36A	Antimony	26.9	6	6	43.26	15	0	4
	IR09MW45F	Antimony	9.1	6	6	--	15	1	3
	IR09MW51F	**Chromium**	**60.7**	**100**	**50**	**--**	**--**	**2**	**3**
	IR09MW51F	Methylene chloride	45	5	5	--	4.3	1	3
	IR09MW51F	**Trichloroethene**	**72**	**5**	**5**	**--**	**1.6**	**3**	**3**
	IR09PPY1	**Chromium**	**395**	**100**	**50**	**15.66**	**--**	**7**	**7**
	IR09P041A	Aluminum	1,430	--	1,000	--	36,000	1	2

TABLE A-1 (Continued)

SUMMARY OF MONITORING WELL GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (μg/L)	EPA Primary MCL (μg/L)[a]	California Primary MCL (μg/L)[b]	HGAL (μg/L)[c]	EPA Region 9 Tap Water PRG (μg/L)[d]	Number of Sampling Events Exceeding Criteria[e]	Number of Sampling Events[f]
IR-09 (cont.)	IR33MW116A	Bis(2-ethylhexyl)phthalate	28	6	4	--	4.8	1	3
	PA50MW12A	Antimony	15.8	6	6	43.26	15	0	3
IR-16	PA16MW16A	Thallium	6.7	2	2	12.97	--	0	3
	PA16MW17A	Thallium	2.2	2	2	12.97	--	0	3
IR-17	IR17MW13A	Antimony	28	6	6	43.26	15	0	3
IR-22	IR22MW07A	Arsenic	62.5	50	50	27.34	0.045	1	3
	IR22MW07A	Lead	15.4	15[k]	15[k]	14.44	--	1 (1)[g]	3
	IR22MW08A	Lead	20.3	15[k]	15[k]	14.44	--	1	2
	IR22MW15A	Lead	18.5	15[k]	15[k]	14.44	--	1	3
	IR22MW16A	Arsenic	50.4	50	50	27.34	0.045	1	3
	IR22MW16A	**Lead**	**26.2**	**15[k]**	**15[k]**	**14.44**	**--**	**2**	**2**
	IR22MW20A	Aluminum	12,333	--	1,000	--	36,000	1	3
	IR22MW20A	Chromium	53.4	100	50	15.66	--	1	3
IR-32	IR70MW12A	Cadmium	9.2	5	5	5.08	--	1	3
IR-33 North	**IR33MW61A**	**Aluminum**	**1,970**	**--**	**1,000**	**--**	**36,000**	**2**	**3**
	IR33MW61A	Arsenic	76.3	50	50	27.34	0.045	1	3
	IR33MW61A	**Benzene**	**650**	**5**	**1**	**--**	**0.39**	**3**	**3**
	IR33MW61A	**Chromium**	**276**	**100**	**50**	**15.66**	**--**	**2**	**3**
	IR33MW61A	Thallium	2.2	2	2	12.97	--	0	3

TABLE A-1 (Continued)

SUMMARY OF MONITORING WELL GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]	Number of Sampling Events Exceeding Criteria[e]	Number of Sampling Events[f]
IR-33 North (cont.)	IR33MW66A	Thallium	2.3	2	2	12.97	--	0	3
IR-33 South	IR09MW44A	Nickel	101	--	100	96.48	730	1	6
	IR09P040A	Benzo(a)pyrene	0.3	0.2	0.2	--	0.0092 (0.0015[h])	1[i] (4)[g]	6
	IR09P043A	Antimony	33.3	6	6	43.26	15	0	2
	IR09P043A	**Nickel**	**185**	**--**	**100**	**96.48**	**730**	**5**	**6**
	PA33MW36A	Antimony	14.2	6	6	43.26	15	0	3
	PA33MW37A	Antimony	17.3	6	6	43.26	15	0	3
	PA33MW37A	Lead	15.1	15[k]	15[k]	14.44	--	1	3
	PA33MW37A	Nickel	317	--	100	96.48	730	1	3
	PA33MW37A	Thallium	10.2	2	2	12.97	--	0	2
IR-34	IR34MW01A	Aluminum	16,800	--	1,000	--	36,000	1	3
	IR34MW01A	Chromium	81.2	100	50	15.66	--	1	3
IR-37	IR37MW01A	Thallium	3.9	2	2	12.97	--	0	3
IR-38	IR38MW01A	Thallium	10.5	2	2	12.97	--	0	3
IR-44	IR44MW08A	Cadmium	24.9	5	5	5.08	18	1	3
IR-55	IR55MW01A	Thallium	3.0	2	2	12.97	--	0	3
	IR55MW02A	Thallium	2.0	2	2	12.97	--	0	3
	IR55MW04A	Thallium	2.2	2	2	12.97	--	0	3
IR-55 (cont.)	PA50MW05A	Lead	42.0	15[k]	15[k]	14.44	--	1	5

TABLE A-1 (Continued)

SUMMARY OF MONITORING WELL GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]	Number of Sampling Events Exceeding Criteria[e]	Number of Sampling Events[f]
IR-65	IR34MW02A	Thallium	4.2	2	2	12.97	--	0	3
IR-67	IR36MW16A	Aluminum	1,160	--	1,000	--	36,000	1	3
	IR36MW16A	Antimony	7.6	6	6	43.26	15	0	3
	IR36MW16A	Thallium	11.9	2	2	12.97	--	0	3
	IR67MW04A	Cadmium	5.7	5	5	5.08	18	1	3
	IR67MW04A	Thallium	50.7	2	2	12.97	--	1	3
IR-70	**IR70MW11A**	**Cadmium**	**24.3**	**5**	**5**	**5.08**	**18**	**2**	**3**
	IR70MW11A	Thallium	3.2	2	2	12.97	--	0	3
IR-71	IR71MW03A	Carbon tetrachloride	0.9	5	0.5	--	0.17	1	3
	IR71MW03A	**Tetrachloroethene**	**25**	**5**	**5**	**--**	**1.1**	**3**	**3**
	IR71MW03A	Thallium	6.0	2	2	12.97	--	0	3
	IR71MW03A	**Trichloroethene**	**17**	**5**	**5**	**--**	**1.6**	**3**	**3**

TABLE A-1 (Continued)

SUMMARY OF MONITORING WELL GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Notes:

Bold type indicates multiple sampling events in which groundwater concentrations exceeded the applicable screening criterion.

EPA	U.S. Environmental Protection Agency
MCL	Maximum contaminant level
HGAL	Hunters Point groundwater ambient level
PRG	Preliminary remediation goal
µg/L	Microgram per liter
--	Not available

a	EPA Office of Ground Water and Drinking Water. 1999. "Current Drinking Water Standards." Accessed on November 17, 1999. On-Line Address: http://www.epa.gov/OGWDW/wot/appa.html.
b	California Department of Health Services. 1999. "Drinking Water Standards, Action Levels, and Unregulated Chemicals Requiring Monitoring." Accessed on January 21, 2000. On-Line Address: http://www.dhs.cahwnet.gov/org/ps/ddwem/chemicals/mcl/mclindex.htm.
c	PRC Environmental Management, Inc. 1996a. "Estimation of Hunters Point Shipyard Groundwater Ambient Levels Technical Memorandum." September 16.
d	EPA. 1999b. "Region 9 Preliminary Remediation Goals 1999." October 1. PRGs are presented for informational purposes only.
e	Number of sampling events exceeding applicable screening criterion (for example, HGALs for metals and the most stringent MCL for other contaminants); wells indicated with no samples exceeding criteria had detected concentrations that exceeded the most stringent MCL but were less than the HGAL.
f	Number of sampling events for listed analyte.
g	Number of sampling events in which the analyte was not detected, but the analytical detection limit exceeded the applicable screening criterion.
h	California-modified PRG.
i	Concentration of benzo(a)pyrene in one additional sample was detected at the MCL of 0.2 µg/L.
j	MCL for total polychlorinated biphenyls
k	Action level for lead (i.e., health-based advisory level and not an enforceable standard)

TABLE A-4

**IR-08 A-AQUIFER MONITORING WELL GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA**

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR08MW37A	Antimony	7/11/90 19.8[a]	1/3/91 < 23.8	7/10/91 < 16.7	11/7/91 NA	12/19/91 < 27.6	3/17/92 NA	8/26/94 NA
	Lead	7/11/90 < 2.2	1/3/91 < 11	7/10/91 < 8	11/7/91 NA	12/19/91 < 20[b]	NS	NS
IR08MW38A	Lead	7/10/90 < 11	1/3/91 < 11	7/10/91 < 1.6	11/7/91 NA	12/20/91 < 20[b]	NS	NS
IR08MW39A	Antimony	7/10/90 34.2[a]	1/3/91 < 23.8	7/10/91 < 16.7	11/7/91 NA	12/20/91 < 27.6	NS	NS
IR08MW40A	Antimony	7/10/90 39.5[a]	1/4/91 < 23.8	7/10/91 25.5[a]	11/7/91 NA	12/19/91 < 27.6	3/17/92 NA	11/8/93 NA
	Bis(2-ethylhexyl)phthalate	7/10/90 < 10[b]	1/4/91 NA	7/10/91 NA	11/7/91 NA	12/19/91 NA	3/17/92 NA	**11/8/93 15**
IR08MW41A	Antimony	7/11/90 37.7[a]	1/4/91 < 23.8	7/11/91 < 16.7	11/7/91 NA	12/19/91 < 27.6	3/17/92 NA	11/5/93 NA
IR08MW42A	Antimony	10/7/91 18.8[a]	12/20/91 < 27.6	NS	NS	NS	NS	NS
	Aroclor-1260	**10/7/91 2.2**	**10/7/91 4.4** [c]	**12/20/91 1.1**	11/4/93 < 1[b]	2/7/94 < 1[b]	5/10/94 < 0.5	8/26/94 < 0.5
	Fluoride	10/7/91 <50,000[b]	NS	NS	NS	NS	NS	NS
IR08MW44A	Thallium	**10/4/94 14.1**	2/5/96 < 1.9	3/7/96 < 1.9	NS	NS	NS	NS

TABLE A-4 (Continued)

Notes: Bold type indicates a sampling event in which the groundwater concentration exceeded the applicable screening criterion.
For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
NA Not analyzed
NS Not sampled
µg/L Micrograms per liter
< Less than the analytical detection limit listed

a The concentration exceeded the most stringent MCL but was less than the HGAL.
b The analytical detection limit exceeds applicable screening criterion.
c Duplicate sample result.

TABLE A-5

IR-09 A-AQUIFER MONITORING WELL GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR09MW35A	Antimony	4/25/90 < 20.1	1/21/91 < 23.8	7/8/91 18.3[a]	10/25/91 NA	12/16/91 < 27.6	2/21/92 NA	11/9/93 NA	2/22/94 NA	5/12/94 NA	9/2/94 NA	7/28/95 < 2.1
	Bis(2-ethylhexyl) phthalate	4/25/90 < 10[b]	1/2/91 NA	7/8/91 NA	10/25/91 NA	12/16/91 NA	2/21/92 NA	11/9/93 < 3	2/22/94 < 10[b]	**5/12/94 39**	9/2/94 < 4	7/28/95 NA
	Chromium	**4/25/90 95.3**	**1/2/96 60.8**	**7/8/91 92.8**	10/25/91 NA	**12/16/91 90.7**	2/21/92 NA	**11/9/93 69.1**	**2/22/94 70.5**	**5/12/94 83.4**	**9/2/94 68.0**	**7/28/95 121**
	Nickel	**4/25/90 112**	**1/2/91 130**	**7/8/91 130**	10/25/91 NA	**12/16/91 112**	2/21/92 NA	**11/9/93 114**	2/22/94 55.7[a]	5/12/94 52.3[a]	9/2/94 61.5[a]	7/28/95 35.5[a]
IR09MW36A	Antimony	4/25/90 < 20.1	1/2/91 < 23.8	7/9/91 26.9[a]	12/16/91 < 27.6	11/12/93 NA	2/24/94 NA	5/11/94 NA	9/6/94 NA	NS	NS	NS
IR09MW44A	Fluoride	10/8/91 <5,000[b]	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
IR09PPY1	Chromium	**4/24/90 198**	**1/3/91 339**	**7/9/91 395**	**12/16/91 310**	**2/23/94 345**	**5/9/94 309**	**9/7/94 193**	NS	NS	NS	NS
IR09P040A	Fluoride	10/8/91 <5,000[b]	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
IR09P041A	Aluminum	**10/7/91 1,430**	12/17/91 <15.3	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Fluoride	10/8/91 <5,000[b]	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
IR09P043A	Fluoride	10/8/91 <5,000[b]	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
IR33MW116A	Bis(2-ethylhexyl) phthalate	10/26/95 < 4	2/28/96 < 4	**4/4/96 28**	NS	NS	NS	NS	NS	NS	NS	NS
PA50MW12A	Antimony	4/28/93 15.8[a]	2/12/96 < 1.6	3/19/96 < 1.6	NS	NS	NS	NS	NS	NS	NS	NS

TABLE A-5 (Continued)

Notes: Bold type indicates a sampling event in which the groundwater concentration exceeded the applicable screening criterion. For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL	Hunters Point groundwater ambient level
MCL	Maximum contaminant level
NA	Not analyzed
NS	Not sampled
µg/L	Micrograms per liter
<	Less than the analytical detection limit listed
a	The concentration exceeded the most stringent MCL but was less than the HGAL.
b	The analytical detection limit exceeds applicable screening criterion.

TABLE A-6

IR-09 BEDROCK WATER-BEARING ZONE MONITORING WELL GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA PARCEL D GROUNDWATER TECHNICAL MEMORANDUM HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR09MW45F	Antimony	**8/10/94 9.1**	1/29/96 < 1.6	2/29/96 < 1.6	NS
IR09MW51F	Chromium	**2/15/96 60.7**	3/18/96 48.4	4/9/96 NA	**5/14/96 51.3**
	Methylene chloride	2/15/96 < 0.5	**3/18/96 45**	4/9/96 NA	5/14/96 < 0.5
	Trichloroethene	**2/15/96 72**	**3/18/96 50**	4/9/96 NA	**5/14/96 27**

Notes: HGALs were not derived for bedrock water-bearing zone groundwater.
Bold print indicates a sampling event in which the groundwater concentration exceeded applicable screening criterion.
For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
NA Not analyzed
NS Not sampled
µg/L Micrograms per liter
< Less than the analytical detection limit listed

TABLE A-7

IR-16 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
PA16MW16A	Thallium	11/16/95 6.7[a]	1/16/96 < 1.9	2/21/96 < 1.9
PA16MW17A	Thallium	11/21/95 2.2[a]	1/22/96 < 1.9	2/22/96 < 1.9

Notes: For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
µg/L Micrograms per liter
< Less than the analytical detection limit listed

a Concentration exceeded the most stringent MCL but was less than the HGAL.

TABLE A-8

IR-17 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)
IR17MW13A	Antimony	8/29/91 < 14.3	2/28/92 28[a]	9/17/92 < 26.3
	Fluoride	8/29/91 < 5,000[b]	NS	NS

Notes: For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
NS Not sampled
μg/L Micrograms per liter
< Less than the analytical detection limit listed

a The concentration exceeded the most stringent MCL but was less than the HGAL.

b The analytical detection limit exceeds applicable screening criterion.

TABLE A-9

IR-22 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR22MW07A	Arsenic	5/18/93 < 2.6	9/9/93 < 6	**1/14/94** **62.5**	NS
	Lead	5/18/93 9.5	9/9/93 < 14.0	**1/14/94** **15.4**	NS
IR22MW08A	Lead	**9/9/93** **20.3**	1/14/94 < 12.0	NS	NS
IR22MW15A	Lead	5/4/93 < 13.0	**5/4/93** **18.5**[a]	9/9/93 < 14.0	1/13/94 < 12.0
IR22MW16A	Arsenic	5/6/93 3.1	9/9/93 < 4.3	**1/14/93** **50.4**	NS
	Lead	**9/9/93** **20.2**	**1/14/94** **16.3**	**1/14/94** **26.1**[a]	NS
IR22MW20A	Chromium	**10/17/94** **53.4**	1/19/96 1.7	2/20/96 < 0.40	NS
	Aluminum	**10/17/94** **12,333**	1/19/96 < 92.4	2/20/96 152	NS

Notes: Bold type indicates a sampling event in which the groundwater concentration exceeded applicable screening criterion.
For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
NS Not sampled
µg/L Micrograms per liter
< Less than the analytical detection limit listed
a Duplicate sample result.

TABLE A-10

IR-32 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)
IR70MW12A	Cadmium	10/20/95 1.8	1/12/96 < 0.2	**2/14/96** **9.2**

Notes: Bold type indicates a sampling event in which the groundwater concentration exceeded applicable screening criterion. For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
μg/L Micrograms per liter
< Less than the analytical detection limit listed

TABLE A-11

IR-33 NORTH A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR33MW61A	Aluminum	8/8/94 < 35.3	**1/16/96** **1,180**	**2/16/96** **1,970**
	Arsenic	**8/8/94** **76.3**	1/16/96 27.6[b]	2/16/96 7.9
	Benzene	**8/8/94** **650**	**1/16/96** **19**	**2/16/96** **4**
	Chromium	8/8/94 < 13.1	**1/16/96** **90.4**	**2/16/96** **276**
	Thallium	8/8/94 < 2.0	1/16/96 2.2[a]	2/16/96 < 1.9
IR33MW66A	Thallium	10/31/94 2.3[a]	1/17/96 2.2[a]	2/20/96 <1.9

Notes: Bold type indicates a sampling event in which the groundwater concentration exceeded applicable screening criterion. For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
µg/L Micrograms per liter
< Less than the analytical detection limit listed

a The concentration exceeded the most stringent MCL but was less than the HGAL.
b The concentration exceeded the HGAL but was less than the most stringent MCL.

TABLE A-12

IR-33 SOUTH A-AQUIFER MONITORING WELL GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR09MW44A	Nickel	10/8/91 < 49.8	12/18/91 51.4	**11/10/93** **101**	2/22/94 63.5	5/11/94 47.4	9/7/94 50.6
IR09P040A	Benzo(a)pyrene	**10/8/91** **0.3**	12/17/91 0.2[c]	11/12/93 < 10[b]	2/24/94 < 10[b]	5/11/94 < 10[b]	9/8/94 < 10[b]
IR09P043A	Antimony	10/8/91 < 14.3	12/18/91 33.3[a]	11/10/93 NA	2/24/94 NA	5/12/94 NA	9/8/94 NA
	Nickel	**10/8/91** **185**	**12/18/91** **134**	**11/10/93** **141**	**2/24/93** **119**	5/12/94 99.6	**9/8/94** **112**
PA33MW36A	Antimony	3/25/93 14.2[a]	2/7/96 < 1.6	3/11/96 < 1.6	NS	NS	NS
PA33MW37A	Antimony	3/25/93 17.3[a]	7/28/95 < 2.1	2/12/96 < 1.6	NS	NS	NS
	Lead	3/25/93 < 2.6	**3/25/93** **15.1[d]**	7/28/95 1.6	2/12/96 < 0.8	NS	NS
	Nickel	3/25/93 61.2	**7/28/95** **317**	2/12/96 38.9	NS	NS	NS
	Thallium	3/25/93 NA	7/28/95 10.2[a]	2/12/96 < 1.9	NS	NS	NS

Notes: Bold type indicates a sampling event in which the groundwater concentration exceeded applicable screening criterion.
For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level

MCL Maximum contaminant level
NA Not analyzed
NS Not sampled
µg/L Micrograms per liter
< Less than the analytical detection limit listed

a The concentration exceeded the most stringent MCL but was less than the HGAL.

b The analytical detection limit exceeds applicable screening criterion.

c The concentration was equal to the most stringent MCL.

d Duplicate sample result.

TABLE A-13

IR-34 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR34MW01A	Aluminum	9/23/94 < 53.96	1/17/96 313	**2/21/96** **16,800**
	Chromium	9/23/94 < 3.5	1/17/96 6.9	**2/21/96** **81.2**

Notes: Bold type indicates a sampling event in which the groundwater concentration exceeded applicable screening criterion. For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level

MCL Maximum contaminant level

µg/L Micrograms per liter

< Less than the analytical detection limit listed

TABLE A-14

**IR-37 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA**

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR37MW01A	Thallium	11/1/94 3.9[a]	1/19/96 < 1.9	2/21/96 < 1.9

Notes: For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
µg/L Micrograms per liter
< Less than the analytical detection limit listed
a The concentration exceeded the most stringent MCL but was less than the HGAL.

TABLE A-15

IR-38 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR38MW01A	Thallium	10/12/94 7.9[a]	1/22/96 10.5[a]	2/22/96 < 1.9

Notes: For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
µg/L Micrograms per liter
< Less than the analytical detection limit listed

a The concentration exceeded the most stringent MCL but was less than the HGAL.

TABLE A-16

IR-44 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR44MW08A	Cadmium	**10/20/95** **24.9**	1/22/96 < 0.20	2/23/96 < 1.0

Notes: Bold type indicates a sampling event in which the groundwater concentration exceeded applicable screening criterion. For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
µg/L Micrograms per liter
< Less than the analytical detection limit listed

TABLE A-17

IR-55 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR55MW01A	Thallium	10/6/94 3.0[a]	2/9/96 < 1.9	3/15/96 < 1.9	NS	NS	NS
IR55MW02A	Thallium	10/7/94 2.0[b]	1/30/96 < 1.9	3/1/96 < 1.9	NS	NS	NS
IR55MW04A	Thallium	10/5/94 2.2[a]	2/9/96 < 1.9	3/15/96 < 1.9	NS	NS	NS
PA50MW05A	Lead	4/22/93 <6.3	4/22/93 13.5[c]	**10/18/93** **42.0**	7/18/95 < 1.5	3/19/96 < 0.8	4/30/96 < 1.0

Notes: For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
µg/L Micrograms per liter
< Less than the analytical detection limit listed

a The concentration exceeded the most stringent MCL but was less than the HGAL.
b The concentration was equal to the most stringent MCL but was less than the HGAL.
c Duplicate sample result.

TABLE A-18

IR-65 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR34MW02A	Thallium	10/11/94 2.8[a]	2/6/96 4.2[a]	3/8/96 3.1[a]

Notes: For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
µg/L Micrograms per liter
< Less than the analytical detection limit listed

a The concentration exceeded the most stringent MCL but was less than the HGAL.

TABLE A-19

IR-67 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)
IR36MW16A	Aluminum	9/27/94 < 35.3	1/31/96 < 18.0	3/5/96 < 19.1	**3/5/96** **1,160[b]**
	Antimony	9/27/94 7.6[a]	1/31/96 < 1.6	3/5/96 < 8	NS
	Thallium	9/27/94 11.9[a]	1/31/96 < 1.9	3/5/96 < 9.5	NS
IR67MW04A	Cadmium	**10/31/95** **5.7**	1/11/96 0.25	2/15/96 < 0.30	4/8/96 NA
	Thallium	**10/31/94** **50.7**	1/11/96 < 8.2	2/15/96 < 1.9	4/8/96 NA

Notes: Bold type indicates a sampling event in which the groundwater concentration exceeded applicable screening criterion. For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
NA Not analyzed
NS Not sampled
μg/L Micrograms per liter
< Less than the analytical detection limit listed

a The concentration exceeded the most stringent MCL but was less than the HGAL.
b Duplicate sample result.

TABLE A-20

IR-70 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR70MW11A	Cadmium	**11/1/95 7.7**	1/12/96 < 0.2	**2/14/96 24.3**
	Thallium	11/1/95 3.2[a]	1/12/96 < 1.9	2/14/96 < 1.9

Notes: Bold type indicates a sampling event in which the groundwater concentration exceeded applicable screening criterion. For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level

MCL Maximum contaminant level

µg/L Micrograms per liter

< Less than the analytical detection limit listed

a The concentration exceeded the most stringent MCL but was less than the HGAL.

TABLE A-21

IR-71 A-AQUIFER MONITORING WELL
GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
PARCEL D GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR71MW03A	Carbon tetrachloride	**10/31/95 0.9**	1/11/96 0.3	2/15/96 < 0.5	4/8/96 NA
	Tetrachloroethene	**10/31/95 16**	**1/11/96 25**	**2/15/96 12**	4/8/96 NA
	Thallium	10/31/95 6.0[a]	1/11/96 < 9.5	2/15/96 < 1.9	4/8/96 NA
	Trichloroethene	**10/31/95 15**	**1/11/96 17**	**2/15/96 12**	4/8/96 NA

Notes: Bold type indicates a sampling event in which the groundwater concentration exceeded applicable screening criterion. For duplicate samples, the reported result is the maximum concentration (unless otherwise noted).

HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
NA Not analyzed
µg/L Micrograms per liter
< Less than the analytical detection limit listed
a The concentration exceeded the most stringent MCL but was less than the HGAL.

LIST OF TABLES
PARCEL C GROUNDWATER EVALUATION

TABLE 1

SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]	Number of Sampling Events that Exceed Criteria [e]	Number of Sampling Events [f]
IR-25	IR06MW41A	Manganese	8,860	--	--	8,140	880	1	4
	IR06MW42A	Benzene	2	5	1	--	0.41	1[g] (4) [h]	8
		Vinyl chloride	0.7	2	0.5	--	0.02	1 (6) [h]	8
	IR06MW44A	Cadmium	6.4	5	5	5.08	--	1	2
		1,2-Dichloroethane	2	5	0.5	--	0.12	1 (2) [h]	4
		Nickel	117	--	100	96.48	730	1	2
		Tetrachloroethene	5	5	5	--	1.1	0 [l]	4
	IR25MW11A	Hexachloroethane	(530) [n]	--	--	--	4.8	1 (1) [h]	2
		Pentachlorophenol	6,100	1	1	--	0.56	1	2
		Vinyl chloride	87	2	0.5	--	0.02	1 (1) [h]	2
	IR25MW15A1	1,1,1-Trichloroethane	720	200	200	--	790	1 (2) [h]	5
		1,1-Dichloroethene	30	7	6	--	0.046	1 (4) [h]	5
		1,2,4-Trichlorobenzene	110	70	70	--	190	1 (1) [h]	3
		1,2-Dichlorobenzene	**62,000**	**600**	**600**	**--**	**370**	**5**	**5**
		1,2-Dichloroethane	**150,000**	**5**	**0.5**	**--**	**0.12**	**5**	**5**
		1,2-Dichloropropane	330	5	5	--	0.16	1 (4) [h]	5
		1,4-Dichlorobenzene	**14,000**	**75**	**5**	**--**	**0.50**	**5**	**5**
		Aroclor-1260	2.0	0.5[j]	0.5[j]	--	0.034	1	3
		Benzene	**140**	**5**	**1**	**--**	**0.41**	**2 (3) [h]**	**5**
		Chlorobenzene	**2,200**	**70**	**70**	**--**	**106.1**	**3 (2) [h]**	**5**
		cis-1,2-Dichloroethene	**58,000**	**70**	**6**	**--**	**61**	**2**	**2**

TABLE 1 (Continued)

SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]	Number of Sampling Events that Exceed Criteria [e]	Number of Sampling Events [f]
IR-25 (cont.)	IR25MW15A1 (cont.)	Heptachlor epoxide	0.03	0.2	0.01	--	0.0074	1	3
		Tetrachloroethene	**56,000**	**5**	**5**	**--**	**1.1**	**5**	**5**
		trans-1,2-Dichloroethene	430	100	10	--	120	1 (1) [h]	2
		Trichloroethene	**10,000**	**5**	**5**	**--**	**1.6**	**5**	**5**
		Vinyl chloride	**6,600**	**2**	**0.5**	**--**	**0.02**	**4 (1) [h]**	**5**
	IR25MW15A2	**1,2-Dichlorobenzene**	**2,800**	**600**	**600**	**--**	**370**	**4**	**4**
		1,2-Dichloroethane	**6,500**	**5**	**0.5**	**--**	**0.12**	**5**	**5**
		1,2-Dichlorpropane	6	5	5	--	0.16	1 (4) [h]	5
		1,4-Dichlorobenzene	**680**	**75**	**5**	**--**	**0.50**	**4**	**4**
		Aroclor-1260	**11.0**	**0.5[j]**	**0.5[j]**	**--**	**0.034**	**3**	**3**
		cis-1,2-Dichloroethene	**1,800**	**70**	**6**	**--**	**61**	**2**	**2**
		Manganese	9,030	--	--	8,140	876	1	4
		Nickel	113	--	100	96.48	730	1	3
		Tetrachloroethene	**5,200**	**5**	**5**	**--**	**1.1**	**5**	**5**
		Thallium	23.6	2	2	12.97	--	1	3
		Trichloroethene	**1,200**	**5**	**5**	**--**	**1.6**	**5**	**5**
		Vinyl chloride	**430**	**2**	**0.5**	**--**	**0.02**	**3 (2) [h]**	**5**
	IR25MW16A	Aroclor-1260	0.98	0.5[j]	0.5[j]	--	0.034	1	3
		Hexachloroethane	8	--	--	--	4.8	1 (2) [h]	3
		Nickel	122	--	100	96.48	730	1	3
		Trichloroethene	**86**	**5**	**5**	**--**	**1.6**	**3**	**3**
	IR25MW17A	1,2-Dichloroethane	2	5	0.5	--	0.12	1 (2) [h]	3
	IR25MW18A	1,1-Dichloroethene	21	7	6	--	0.046	1	1

TABLE 1 (Continued)

SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (μg/L)	EPA Primary MCL (μg/L)[a]	California Primary MCL (μg/L)[b]	HGAL (μg/L)[c]	EPA Region 9 Tap Water PRG (μg/L)[d]	Number of Sampling Events that Exceed Criteria [e]	Number of Sampling Events [f]
IR-25 (cont.)	IR25MW18A (cont.)	1,2-Dichlorobezene	15,000	600	600	--	370	1	1
		1,2-Dichloroethane	43,000	5	0.5	--	0.12	1	1
		1,2-Dichloropropane	59	5	5	--	0.16	1	1
		cis-1,2-Dichloroethene	13,000	70	6	--	61	1	1
		Tetrachloroethene	7,300	5	5	--	1.1	1	1
		trans-1,2-Dichloroethene	850	100	10	--	120	1	1
		Benzene	22	5	1	--	0.41	1	1
		Trichloroethene	9,000	5	5	--	1.6	1	1
		Vinyl chloride	3,600	2	0.5	--	0.02	1	1
	IR25MW19A	1,1-Dichloroethene	17	7	6	--	0.046	1	1
		1,2,4-Trichlorobenzene	200	70	70	--	190	1	1
		1,2-Dichlorobenzene	59,000	600	600	--	370	1	1
		1,2-Dichloroethane	91,000	5	0.5	--	0.12	1	1
		1,2-Dichloropropane	350	5	5	--	0.16	1	1
		1,4-Dichlorobenzene	15,000	75	5	--	0.50	1	1
		cis-1,2-Dichloroethene	27,000	70	6	--	61	1	1
		Benzene	50	5	1	--	0.41	1	1
		Chlorobenzene	330	70	70	--	106.1	1	1
		Fluoride	2,900	4,000	2,000	--	2,200	1	1
		Manganese	10,400	--	--	8,140	876	1	1
		Methylene chloride	190	5	5	--	4.3	1	1
		Tetrachloroethene	72,000	5	5	--	1.1	1	1
		trans-1,2-Dichloroethene	1,800	100	10	--	120	1	1
		Trichloroethene	8,900	5	5	--	1.6	1	1

TABLE 1 (Continued)

SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (μg/L)	EPA Primary MCL (μg/L)[a]	California Primary MCL (μg/L)[b]	HGAL (μg/L)[c]	EPA Region 9 Tap Water PRG (μg/L)[d]	Number of Sampling Events that Exceed Criteria [e]	Number of Sampling Events [f]
IR-25 (cont.)	IR25MW19A (cont.)	Vinyl chloride	3,000	2	0.5	--	0.02	1	1
	IR25MW20A	1,2-Dichloroethane	2	5	0.5	--	0.12	1	1
		Fluoride	3,700	4,000	2,000	--	2,200	1	1
		Tetrachloroethene	12	5	5	--	1.1	1	1
IR-28	IR28MW124A	Selenium	50.1	50	50	14.5	180	1	3
	IR28MW125A	**Chromium**	**286**	**100**	**50**	**15.66**	**--**	**3**	**3**
		Trichloroethene	**10**	**5**	**5**	**--**	**1.6**	**3**	**3**
	IR28MW126A	Aluminum	2,250	--	1,000	--	36,000	1	4
		Chromium	88	100	50	15.66	--	1	4
		Lead	25.6	15[k]	15[k]	14.44	--	1	4
		Mercury	3	2	2	0.60	11	1	4
		Nickel	187	--	100	96.48	730	1	4
		Tetrachloroethene	**10**	**5**	**5**	**--**	**1.1**	**3**	**4**
		Trichloroethene	6	5	5	--	1.6	1[g] (1) [h]	4
		Vinyl chloride	0.8	2	0.50	--	0.02	1 (3) [h]	4
	IR28MW127A	Aluminum	1,190	--	1,000	--	36,000	1	3
		Chromium	71.6	100	50	15.66	--	1	3
		cis-1,2-Dichloroethene	(210) [n]	70	6	--	61	1	1
		Lead	29.7	15[k]	15[k]	14.44	--	1	3
		Mercury	4.8	2	2	0.60	11	1	3
		Nickel	146	--	100	96.48	730	1	3
		Tetrachloroethene	**380**	**5**	**5**	**--**	**1.1**	**3**	**3**

TABLE 1 (Continued)

SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]	Number of Sampling Events that Exceed Criteria [e]	Number of Sampling Events [f]
IR-28 (cont.)	IR28MW127A (cont.)	trans-1,2-Dichlororethene	(40) [n]	100	10	--	120	1	1
		Trichloroethene	**55**	**5**	**5**	**--**	**1.6**	**3**	**3**
	IR28MW128A	**Benzene**	**37**	**5**	**1**	**--**	**0.41**	**3**	**3**
		Trichloroethene	**68**	**5**	**5**	**--**	**1.6**	**3**	**3**
		Vinyl chloride	**150**	**2**	**0.5**	**--**	**0.02**	**3**	**3**
	IR28MW129A	Aroclor-1260	23.0	0.5[j]	0.5[j]	--	0.034	1	3
		Chromium	50.6	100	50	15.66	--	1	3
		Nickel	117.8	--	100	96.48	730	1	3
	IR28MW136A	**Benzene**	**9**	**5**	**1**	**--**	**0.41**	**2 (2) [h]**	**4**
		cis-1,2-Dichloroethene	250	70	6	--	61	1	1
		Tetrachloroethene	11	5	5	--	1.1	1 (3) [h]	4
		trans-1,2-Dichloroethene	13	100	10	--	120	1	1
		Trichloroethene	**11**	**5**	**5**	**--**	**1.6**	**2 (2) [h]**	**4**
		Vinyl chloride	**550**	**2**	**0.5**	**--**	**0.02**	**4**	**4**
	IR28MW151A	Tetrachloroethene	15	5	5	--	1.1	1 (2) [h]	3
		Trichloroethene	**700**	**5**	**5**	**--**	**1.6**	**3**	**3**
		Vinyl chloride	**330**	**2**	**0.5**	**--**	**0.02**	**3**	**3**
	IR28MW155A	**Benzene**	**11**	**5**	**1**	**--**	**0.41**	**3 (1) [h]**	**4**
	IR28MW169A	**1,4-Dichlorobenzene**	**14**	**75**	**5**	**--**	**0.50**	**3**	**3**
	IR28MW171A	**Aroclor-1260**	**2.9**	**0.5[j]**	**0.5[j]**	**--**	**0.034**	**2**	**3**
	IR28MW200A	Trichloroethene	6	5	5	--	1.6	1 (1) [h]	3
	IR28MW290A	bis(2-Ethylhexyl)phthalate	49	6	4	--	4.8	1 (2) [h]	3
	IR28MW293A	Thallium	13.9	2	2	12.97	--	1	3

TABLE 1 (Continued)

SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]	Number of Sampling Events that Exceed Criteria [e]	Number of Sampling Events [f]
IR-28 (cont.)	IR28MW294A	Aluminum	26,300	--	1,000	--	36,000	1	3
		Chromium	267	100	50	15.66	--	1	3
		Nickel	384	--	100	96.48	730	1	3
	IR28MW298A	**Trichloroethene**	**9**	**5**	**5**	**--**	**1.6**	**3**	**3**
	IR28MW311A	Benzo(a)pyrene	3	0.2	0.2	--	0.0092 (0.0015[i])	1 (2) [h]	3
		Heptachlor epoxide	0.03	0.2	0.01	--	0.0074	1	3
		Manganese	10,500	--	--	8,140	876	1	3
		Trichloroethene	**53**	**5**	**5**	**--**	**1.6**	**3**	**3**
	IR28MW324A	Benzene	(2) [n]	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	(10) [n]	70	6	--	61	1	1
		Vinyl chloride	(52) [n]	2	0.5	--	0.02	1	1
	IR28MW325A	Benzene	(5) [n]	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	(9) [n]	70	6	--	61	1	1
		Vinyl chloride	(66) [n]	2	0.5	--	0.02	1	1
	IR28MW326A	cis-1,2-Dichloroethene	(7) [n]	70	6	--	61	1	1
	IR28MW327A	Benzene	3	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	130	70	6	--	61	1	1
		Trichloroethene	6	5	5	--	1.6	1	1
		Vinyl chloride	110	2	0.5	--	0.02	1	1
	IR28MW328A	Benzene	2	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	58	70	6	--	61	1	1
		Vinyl chloride	86	2	0.5	--	0.02	1	1

TABLE 1 (Continued)

SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]	Number of Sampling Events that Exceed Criteria [e]	Number of Sampling Events [f]
IR-28 (cont.)	IR28MW329A	Benzene	2	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	91	70	6	--	61	1	1
		Tetrachloroethene	5	5	5	--	1.1	0 [l]	1
		Trichloroethene	6	5	5	--	1.6	1	1
		Vinyl chloride	74	2	0.5	--	0.02	1	1
	IR28MW330A	Benzene	2	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	190	70	6	--	61	1	1
		Tetrachloroethene	23	5	5	--	1.1	1	1
		Trichloroethene	8	5	5	--	1.6	1	1
		Vinyl chloride	92	2	0.5	--	0.02	1	1
	IR28MW331A	Benzene	3	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	260	70	6	--	61	1	1
		Tetrachloroethene	39	5	5	--	1.1	1	1
		Trichloroethene	12	5	5	--	1.6	1	1
		Vinyl chloride	130	2	0.5	--	0.02	1	1
	IR28MW333A	Benzene	1	5	1	--	0.41	0 [l]	1
		cis-1,2-Dichloroethene	13	70	6	--	61	1	1
		Tetrachloroethene	6	5	5	--	1.1	1	1
		Vinyl chloride	13	2	0.5	--	0.02	1	1
	IR28MW334A	Benzene	3	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	510	70	6	--	61	1	1
		Tetrachloroethene	24	5	5	--	1.1	1	1
		trans-1,2-Dichloroethene	10	100	10	--	120	0 [l]	1

TABLE 1 (Continued)

**SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA**

Site	Station	Analyte	Maximum Detected Concentration (μg/L)	EPA Primary MCL (μg/L)[a]	California Primary MCL (μg/L)[b]	HGAL (μg/L)[c]	EPA Region 9 Tap Water PRG (μg/L)[d]	Number of Sampling Events that Exceed Criteria [e]	Number of Sampling Events [f]
IR-28 (cont.)	IR28MW334A (cont.)	Trichloroethene	13	5	5	--	1.6	1	1
		Vinyl chloride	230	2	0.5	--	0.02	1	1
	IR28MW335A	Benzene	2	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	270	70	6	--	61	1	1
		Tetrachloroethene	13	5	5	--	1.1	1	1
		trans-1,2-Dichloroethene	10	100	10	--	120	0 [l]	1
		Trichloroethene	11	5	5	--	1.6	1	1
		Vinyl chloride	120	2	0.5	--	0.02	1	1
	IR28MW336A	Benzene	2	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	460	70	6	--	61	1	1
		Tetrachloroethene	23	5	5	--	1.1	1	1
		trans-1,2-Dichloroethene	10	100	10	--	120	0 [l]	1
		Trichloroethene	14	5	5	--	1.6	1	1
		Vinyl chloride	170	2	0.5	--	0.02	1	1
	IR28MW337A	Benzene	2	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	430	70	6	--	61	1	1
		Tetrachloroethene	92	5	5	--	1.1	1	1
		Trichloroethene	19	5	5	--	1.6	1	1
		Vinyl chloride	150	2	0.5	--	0.02	1	1
	IR28MW338A	cis-1,2-Dichloroethene	(74) [n]	70	6	--	61	1	1
		Tetrachloroethene	(190) [n]	5	5	--	1.1	1	1
		Trichloroethene	(20) [n]	5	5	--	1.6	1	1
		Vinyl chloride	(18) [n]	2	0.5	--	0.02	1	1

TABLE 1 (Continued)

SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]	Number of Sampling Events that Exceed Criteria [e]	Number of Sampling Events [f]
IR-28 (cont.)	IR28MW339A	Benzene	2 (3) [n]	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	280 (620) [n]	70	6	--	61	1	1
		Tetrachloroethene	6 (9) [n]	5	5	--	1.1	1	1
		Trichloroethene	6 (10) [n]	5	5	--	1.6	1	1
		Vinyl chloride	60 (140) [n]	2	0.5	--	0.02	1	1
	IR28MW340A	Benzene	3 (3) [n]	5	1	--	0.41	1	1
		cis-1,2-Dichloroethene	(72) [n]	70	6	--	61	1	1
		Vinyl chloride	19 (12) [n]	2	0.5	--	0.02	1	1
	IR58MW31A	1,1,2,2-Tetrachloroethane	6	--	1	--	--	1 (3)[h]	4
		1,1-Dichloroethane	5	--	5	--	810	0[l] (3)[h]	5
		1,1-Dichloroethene	7	7	6	--	0.046	1 (3)[h]	4
		1,2-Dichlorobenzene	**3,300**	**600**	**600**	**--**	**370**	**3**	**4**
		1,4-Dichlorobenzene	**760**	**75**	**5**	**--**	**0.50**	**4**	**4**
		Aroclor-1260	**3.6**	**0.5[j]**	**0.5[j]**	**--**	**0.034**	**2**	**3**
		Benzene	**12**	**5**	**1**	**--**	**0.41**	**2 (2)[h]**	**5**
		Chlorobenzene	**230**	**70**	**70**	**--**	**106.1**	**3**	**4**
		cis-1,2-Dichloroethene	3,600	70	6	--	61	1	1
		Tetrachloroethene	10	5	5	--	1.1	1(3)[h]	4
		Vinyl chloride	**800**	**2**	**0.5**	**--**	**0.02**	**3 (1)[h]**	**4**
	PA28MW50A	**Benzene**	**11**	**5**	**1**	**--**	**0.41**	**2 (1)[h]**	**3**
		Tetrachloroethene	**14**	**5**	**5**	**--**	**1.1**	**2 (1)[h]**	**3**
		Trichloroethene	**48**	**5**	**5**	**--**	**1.6**	**3**	**3**
		Vinyl chloride	**170**	**2**	**0.5**	**--**	**0.02**	**3**	**3**
	PA28MW51A	**Benzene**	**9**	**5**	**1**	**--**	**0.41**	**2 (1)[h]**	**3**

TABLE 1 (Continued)

SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]	Number of Sampling Events that Exceed Criteria [e]	Number of Sampling Events [f]
IR-28 (cont.)	PA28MW51A (cont.)	bis(2-Ethylhexyl)phthalate	77	6	4	--	4.8	1	3
	PA28MW52A	Benzo(a)pyrene	2	0.2	0.2	--	0.0092 (0.0015[i])	1 (2)[h]	3
		Vinyl chloride	2	2	0.5	--	0.02	1 (2)[h]	3
	PA50MW03A	bis(2-Ethylhexyl)phthalate	99	6	4	--	4.8	1 (1)[h]	3
		Cadmium	6.2	5	5	5.08	--	1	3
	IR28MW314B	Benzene	1	5	1	--	0.41	0 [m]	3
		Vinyl chloride	**58**	**2**	**0.5**	**--**	**0.02**	**3**	**3**
	IR58MW32B	**Tetrachloroethene**	**28**	**5**	**5**	**--**	**1.1**	**3**	**3**
		Trichloroethene	**8**	**5**	**5**	**--**	**1.6**	**2[g]**	**3**
		Vinyl chloride	**1**	**2**	**0.5**	**--**	**0.02**	**2**	**3**
	IR58MW33B	1,1-Dichloroethane	7	--	5	--	810	1	3
		1,2-Dichloropropane	6	5	5	--	0.16	1	3
		1,4-Dichlorobenzene	**46**	**75**	**5**	**--**	**0.50**	**3**	**3**
		Benzene	6	5	1	--	0.41	1[g]	3
		Carbon tetrachloride	3	5	0.5	--	0.17	1 (2)[h]	3
		Tetrachloroethene	**10**	**5**	**5**	**--**	**1.1**	**3**	**3**
		Trichloroethene	**15**	**5**	**5**	**--**	**1.6**	**2[g]**	**3**
		Vinyl chloride	**91**	**2**	**0.5**	**--**	**0.02**	**3**	**3**
	IR28MW172F	Thallium	2.4	2	2	--	--	1	3
	IR28MW188F	**Carbon tetrachloride**	**17**	**5**	**0.5**	**--**	**0.17**	**3**	**3**
	IR28MW189F	**Trichloroethene**	**14**	**5**	**5**	**--**	**1.6**	**3**	**3**

TABLE 1 (Continued)

SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (µg/L)	EPA Primary MCL (µg/L)[a]	California Primary MCL (µg/L)[b]	HGAL (µg/L)[c]	EPA Region 9 Tap Water PRG (µg/L)[d]	Number of Sampling Events that Exceed Criteria [e]	Number of Sampling Events [f]
IR-28 (cont.)	IR28MW190F	**Carbon tetrachloride**	**18**	**5**	**0.5**	**--**	**0.17**	**3**	**3**
		Trichloroethene	**10**	**5**	**5**	**--**	**1.6**	**3**	**3**
	IR28MW201F	Thallium	3.3	2	2	--	--	1 (1) [h]	3
	IR28MW211F	**1,1,2-Trichloroethane**	**39**	**5**	**5**	**--**	**0.20**	**2 (4) [h]**	**6**
		1,2-Dichloroethane	36	5	0.5	--	0.12	1 (5) [h]	6
		Carbon tetrachloride	**100**	**5**	**0.5**	**--**	**0.17**	**2 (4) [h]**	**6**
		Chloroform	**580**	**5.8**	**5.8**	**--**	**0.16**	**2 (4) [h]**	**6**
		cis-1,2-Dichloroethene	48	70	6	--	61	1	1
		Tetrachloroethene	36	5	5	--	1.1	1 (4) [h]	6
		Trichloroethene	**61,000**	**5**	**5**	**--**	**1.6**	**6**	**6**
	IR28MW255F	Thallium	3.0	2	2	--	--	1 (2) [h]	3
	IR28MW273F	**Trichloroethene**	**24**	**5**	**5**	**--**	**1.6**	**3**	**3**
	IR28MW275F	Carbon tetrachloride	0.8	5	0.5	--	0.17	1 (1) [h]	3
		Tetrachloroethene	**33**	**5**	**5**	**--**	**1.1**	**2 (1) [h]**	**3**
		Trichloroethene	**130**	**5**	**5**	**--**	**1.6**	**2 (1) [h]**	**3**
	IR28MW300F	**Carbon tetrachloride**	**17**	**5**	**0.5**	**--**	**0.17**	**3**	**3**
		Trichloroethene	**40**	**5**	**5**	**--**	**1.6**	**3**	**3**
	IR28MW310F	**Carbon tetrachloride**	**8**	**5**	**0.5**	**--**	**0.17**	**3**	**3**
		Trichloroethene	**64**	**5**	**5**	**--**	**1.6**	**3**	**3**
	IR28MW312F	Carbon tetrachloride	0.6	5	0.5	--	0.17	1	3
		Trichloroethene	**20**	**5**	**5**	**--**	**1.6**	**3**	**3**
	IR28MW341F	1,2-Dichloroethane	3	5	0.5	--	0.12	1	1
		Carbon tetrachloride	44	5	0.5	--	0.17	1	1

TABLE 1 (Continued)

SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Site	Station	Analyte	Maximum Detected Concentration (μg/L)	EPA Primary MCL (μg/L)[a]	California Primary MCL (μg/L)[b]	HGAL (μg/L)[c]	EPA Region 9 Tap Water PRG (μg/L)[d]	Number of Sampling Events that Exceed Criteria [e]	Number of Sampling Events [f]
IR-28 (cont.)	IR28MW341F (cont.)	Chloroform	180	70	70	--	106.1	1	1
		cis-1,2-Dichloroethene	22	70	6	--	61	1	1
		Tetrachloroethene	18	5	5	--	1.1	1	1
		Trichloroethene	2,900	5	5	--	1.6	1	1
	IR28MW342F	Carbon tetrachloride	11	5	0.5	--	0.17	1	1
		cis-1,2-Dichloroethene	10	70	6	--	61	1	1
		Tetrachloroethene	46	5	5	--	1.1	1	1
		Trichloroethene	930	5	5	--	1.6	1	1
IR-29	PA50MW04A	bis(2-Ethylhexyl)phthalate	64	6	4	--	4.8	1 (1)[h]	3
	IR29MW48A	Aroclor-1248	1.9	0.5[j]	0.5[j]	--	0.034	1	3
	IR29MW58F	**Thallium**	**5.2**	**2**	**2**	**--**	**--**	**2 (1)[h]**	**3**
	IR29MW72F	Antimony	22.5	6	6	--	15	1 (1)[h]	3
		Benzene	4	5	1	--	0.41	1 (2)[h]	3
		Chromium	**195**	**100**	**50**	**--**	**--**	**3**	**3**
	IR29MW85F	**Antimony**	**10.4**	**6**	**6**	**--**	**15**	**3**	**3**
	IR50MW13F	Aroclor-1260	1.3	0.5[j]	0.5[j]	--	0.034	1	3
		Thallium	2.23	2	2	--	--	1 (1)[h]	3
IR-58	IR58MW25F	**Chromium**	**63.1**	**100**	**50**	**--**	**--**	**3**	**3**
IR-64	IR64MW05A	Vinyl chloride	1	2	0.5	--	0.02	1	3

TABLE 1 (Continued)

SUMMARY OF RESULTS FOR GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Notes: Bold type indicates that the concentration in groundwater samples exceeded the screening criteria in more than one sample.

µg/L	Microgram per liter
EPA	U.S. Environmental Protection Agency
HGAL	Hunters Point groundwater ambient level
MCL	Maximum contaminant level
PRG	Preliminary remediation goal
--	Not available
[a]	EPA Office of Ground Water and Drinking Water. 1999. "Current Drinking Water Standards." Accessed on November 17, 1999. On-Line Address: http://www.epa.gov/OGWDW/wot/appa.html.
[b]	California Department of Health Services. 1999. "Drinking Water Standards, Action Levels, and Unregulated Chemicals Requiring Monitoring." Accessed on November 17, 1999. On-Line Address: http://www.dhs.cahwnet.gov/org/ps/ddwem/chemicals/mcl/mclindex.htm.
[c]	PRC Environmental Management, Inc. 1996. "Estimation of Hunters Point Shipyard Groundwater Ambient Levels Technical Memorandum." September 16.
[d]	EPA. 1999. "Region 9 Preliminary Remediation Goals 1999." October 1. PRGs are presented for informational purposes only.
[e]	Number of sampling events when applicable screening criterion were exceeded (for example, HGALs for metals and the most stringent MCL for other contaminants); wells indicated with no samples exceeding criteria had detected concentrations that exceeded the most stringent MCL but were less than the HGAL.
[f]	Number of sampling events for listed analyte.
[g]	Concentration of analyte in one additional sample was detected at the most stringent MCL.
h	Number of sampling events in which the analyte was not detected, but the analytical detection limit exceeded the applicable screening criterion.
[i]	California-modified PRG.
[j]	MCL for total polychlorinated biphenyls.
[k]	Action level for lead (i.e., health-based advisory level and not an enforceable standard).
[l]	Concentration of one sample was detected at the most stringent MCL.
[m]	Concentrations of analyte in two samples were detected at the most stringent MCL.
[n]	Sampling result collected as a grab sample.

TABLE 2

**RESULTS FOR IR-25 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA**

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR06MW41A	Manganese	6/11/90 749	1/3/91 3,420	**7/16/91 8,860**	1/8/92 7,150	11/8/93 NA	2/16/94 NA	5/13/94 NA	8/19/94 NA	NS
IR06MW42A	Benzene	6/13/90 < 5[b]	1/7/91 < 5[b]	**7/16/91 2**	1/10/92 < 5[b]	11/8/93 1[c]	2/14/94 < 1	5/16/94 0.7	8/25/94 < 2[b]	NS
	Vinyl chloride	6/13/90 < 10[b]	1/7/91 < 10[b]	7/16/91 < 10[b]	1/10/92 < 10[b]	11/8/93 < 1	**2/14/94 0.7**	5/16/94 < 0.5	8/25/94 < 2[b]	NS
IR06MW44A	1,2-Dichloroethane	10/31/91 < 5[b]	1/7/92 < 5[b]	8/25/94 < 0.5[b]	**1/27/98 2**	NS	NS	NS	NS	NS
	Cadmium	10/31/91 < 2.3	**1/7/92 6.4**	8/25/94 NA	1/27/98 NA	NS	NS	NS	NS	NS
	Nickel	**10/31/91 117**	1/7/92 89.4	8/25/94 NA	1/27/98 NA	NS	NS	NS	NS	NS
	Tetrachloroethene	10/31/91 < 5	1/7/92 < 5	8/25/94 < 0.5	1/27/98 5[c]	NS	NS	NS	NS	NS
IR25MW11A	Hexachloroethane	**11/24/93 530[d]**	12/28/93 NA	8/18/94 < 1,000[b]	6/7/95 NA	NS	NS	NS	NS	NS
	Pentachlorophenol	12/28/93 NA	8/18/94 < 2,500[b]	**6/7/95 6,100**	NS	NS	NS	NS	NS	NS
	Vinyl chloride	12/28/93 < 1,000[b]	8/18/94 NA	**6/7/95 87**	NS	NS	NS	NS	NS	NS
IR25MW15A1	1,1,1-Trichloroethane	**6/13/94 720**	6/14/94 NA	8/11/94 < 10,000[b]	5/26/95 < 10	10/5/95 < 2,000[b]	2/3/98 < 100	NS	NS	NS
	1,1-Dichloroethene	6/13/94 < 1,000[b]	6/14/94 NA	8/11/94 < 10,000[b]	**5/26/95 30**	10/5/95 < 2,000[b]	2/3/98 < 100[b]	NS	NS	NS
	1,2,4-Trichlorobenzene	6/13/94 NA	**6/14/94 110**	8/11/94 < 200[b]	5/26/95 NA	10/5/95 NA	2/3/98 < 1	NS	NS	NS

TABLE 2 (CONTINUED)

RESULTS FOR IR-25 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR25MW15A1 (cont.)	1,2-Dichlorobenzene	**6/13/94 37,000**	**6/14/94 62,000**	**8/11/94 19,000**	**5/26/95 2,700**	10/5/95 NA	**2/3/98 39,000**	NS	NS	NS
	1,2-Dichloroethane	**6/13/94 30,000**	6/14/94 NA	**8/11/94 140,000**	**5/26/95 150,000**	**10/5/95 100,000**	**2/3/98 13,000**	NS	NS	NS
	1,2-Dichloropropane	6/13/94 < 1,000[b]	6/14/94 NA	8/11/94 < 10,000[b]	**5/26/95 330**	10/5/95 < 2,000[b]	2/3/98 < 100[b]	NS	NS	NS
	1,4-Dichlorobenzene	**6/13/94 7,800**	**6/14/94 14,000**	**8/11/94 5,900**	**5/26/95 8,100**	10/5/95 NA	**2/3/98 9,600**	NS	NS	NS
	Aroclor-1260	6/13/94 NA	**6/14/94 2**	8/11/94 < 0.5	5/26/95 < 0.5	10/5/95 NA	2/3/98 NA	NS	NS	NS
	Benzene	6/13/94 < 1,000[b]	6/14/94 NA	8/11/94 < 10,000[b]	**5/26/95 43**	10/5/95 < 2,000[b]	**2/3/98 140**	NS	NS	NS
	Chlorobenzene	6/13/94 < 1,000[b]	6/14/94 NA	8/11/94 < 10,000[b]	**5/26/95 420**	**10/5/95 2,200**	**2/3/98 1,700**	NS	NS	NS
	cis-1,2-Dichloroethene	**6/13/94 25,000**	6/14/94 NA	8/11/94 NA	5/26/95 NA	10/5/95 NA	**2/3/98 58,000**	NS	NS	NS
	Heptachlor epoxide	6/13/94 NA	**6/14/94 0.03**	8/11/94 < 0.01	5/26/95 < 0.01	10/5/95 NA	2/3/98 NA	NS	NS	NS
	Tetrachloroethene	**6/13/94 30,000**	6/14/94 NA	**8/11/94 50,000**	**5/26/95 54,000**	**10/5/95 56,000**	**2/3/98 18,000**	NS	NS	NS
	trans-1,2-Dichloroethene	6/13/94 < 1,000[b]	6/14/94 NA	8/11/94 NA	5/26/95 NA	10/5/95 NA	**2/3/98 430**	NS	NS	NS
	Trichloroethene	**6/13/94 4,200**	6/14/94 NA	**8/11/94 4,100**	**5/26/95 6,400**	**10/5/95 10,000**	**2/3/98 10,000**	NS	NS	NS
	Vinyl chloride	**6/13/94 1,400**	6/14/94 NA	8/11/94 < 10,000[b]	**5/26/95 2,400**	**10/5/95 6,600**	**2/3/98 4,200**	NS	NS	NS
IR25MW15A2	1,2-Dichlorobenzene	**6/10/94 1,000**	**8/11/94 2,700**	**5/26/95 1,100**	10/5/95 NA	**2/3/98 2,800**	NS	NS	NS	NS

TABLE 2 (CONTINUED)

RESULTS FOR IR-25 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR25MW15A2 (cont.)	1,2-Dichloroethane	**6/10/94 2,400**	**8/11/94 4,500**	**5/26/95 1,700**	**10/5/95 6,500**	**2/3/98 6,200**	NS	NS	NS	NS
	1,2-Dichloropropane	6/10/94 < 50[b]	8/11/94 < 50[b]	5/26/95 < 50[b]	10/5/95 < 20[b]	**2/3/98 6**	NS	NS	NS	NS
	1,4-Dichlorobenzene	**6/10/94 360**	**8/11/94 680**	**5/26/95 270**	10/5/95 NA	**2/3/98 280**	NS	NS	NS	NS
	Aroclor-1260	**6/10/94 5.4**	**8/11/94 11**	**5/26/95 8.5**	10/5/95 NA	2/3/98 NA	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**6/10/94 190**	8/11/94 NA	5/26/95 NA	10/5/95 NA	**2/3/98 1,800**	NS	NS	NS	NS
	Manganese	6/10/94 4,300	8/11/94 6,550	**5/26/95 9,030**	10/5/95 NA	2/3/98 7,570	NS	NS	NS	NS
	Nickel	6/10/94 33.4[a]	8/11/94 61.0[a]	**5/26/95 113**	10/5/95 NA	2/3/98 NA	NS	NS	NS	NS
	Tetrachloroethene	**6/10/94 4,000**	**8/11/94 5,200**	**5/26/95 600**	**10/5/95 720**	**2/3/98 130**	NS	NS	NS	NS
	Thallium	6/10/94 7.1[a]	8/11/94 8.6[a]	**5/26/95 23.6**	10/5/95 NA	2/3/98 NA	NS	NS	NS	NS
	Trichloroethene	**6/10/94 71**	**8/11/94 350**	**5/26/95 170**	**10/5/95 1,200**	**2/3/98 220**	NS	NS	NS	NS
	Vinyl chloride	6/10/94 < 50[b]	8/11/94 < 500[b]	**5/26/95 41**	**10/5/95 350**	**2/3/98 430**	NS	NS	NS	NS

TABLE 2 (CONTINUED)

RESULTS FOR IR-25 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR25MW16A	Aroclor-1260	6/1/94 NA	6/2/94 < 0.5	8/18/94 NA	8/19/94 < 0.5	**6/1/95 0.98**	NS	NS	NS	NS
	Hexachloroethane	6/1/94 NA	6/2/94 < 10[b]	8/18/94 NA	8/19/94 < 10[b]	**6/1/95 8**	NS	NS	NS	NS
	Nickel	6/1/94 NA	**6/2/94 122**	8/18/94 NA	8/19/94 < 7.9	6/1/95 < 7.5	NS	NS	NS	NS
	Trichloroethene	**6/1/94 6**	6/2/94 NA	**8/18/94 86**	8/19/94 NA	**6/1/95 66**	NS	NS	NS	NS
IR25MW17A	1,2-Dichloroethane	**6/30/94 2**	7/1/94 NA	8/18/94 < 10[b]	8/19/94 NA	6/1/95 < 10[b]	6/2/95 NA	NS	NS	NS
IR25MW18A	1,1-Dichloroethene	**1/29/98 21**	NS	NS	NS	NS	NS	NS	NS	NS
	1,2-Dichlorobenzene	**1/29/98 15,000**	NS	NS	NS	NS	NS	NS	NS	NS
	1,2-Dichloroethane	**1/29/98 43,000**	NS	NS	NS	NS	NS	NS	NS	NS
	1,2-Dichloropropane	**1/29/98 59**	NS	NS	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/29/98 13,000**	NS	NS	NS	NS	NS	NS	NS	NS
	Benzene	**1/29/98 22**	NS	NS	NS	NS	NS	NS	NS	NS
	Chlorobenzene	**1/29/98 99**	NS	NS	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	**1/29/98 7,300**	NS	NS	NS	NS	NS	NS	NS	NS
	trans-1,2-Dichloroethene	**1/29/98 850**	NS	NS	NS	NS	NS	NS	NS	NS

TABLE 2 (CONTINUED)

RESULTS FOR IR-25 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR25MW18A (cont.)	Trichloroethene	**1/29/98 9,000**	NS	NS	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/29/98 3,600**	NS	NS	NS	NS	NS	NS	NS	NS
IR25MW19A	1,1-Dichloroethene	**1/29/98 17**	NS	NS	NS	NS	NS	NS	NS	NS
	1,2,4-Trichlorobenzene	**1/29/98 200**	NS	NS	NS	NS	NS	NS	NS	NS
	1,2-Dichlorobenzene	**1/29/98 59,000**	NS	NS	NS	NS	NS	NS	NS	NS
	1,2-Dichloroethane	**1/29/98 91,000**	NS	NS	NS	NS	NS	NS	NS	NS
	1,2-Dichloropropane	**1/29/98 350**	NS	NS	NS	NS	NS	NS	NS	NS
	1,4-Dichlorobenzene	**1/29/98 15,000**	NS	NS	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/29/98 27,000**	NS	NS	NS	NS	NS	NS	NS	NS
	Benzene	**1/29/98 50**	NS	NS	NS	NS	NS	NS	NS	NS
	Chlorobenzene	**1/29/98 330**	NS	NS	NS	NS	NS	NS	NS	NS
	Fluoride	**1/29/98 2,900**	NS	NS	NS	NS	NS	NS	NS	NS
	Manganese	**1/29/98 10,400**	NS	NS	NS	NS	NS	NS	NS	NS
	Methylene chloride	**1/29/98 190**	NS	NS	NS	NS	NS	NS	NS	NS

TABLE 2 (CONTINUED)

RESULTS FOR IR-25 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR25MW19A (cont.)	Tetrachloroethene	**1/29/98 72,000**	NS	NS	NS	NS	NS	NS	NS	NS
	trans-1,2-Dichloroethene	**1/29/98 1,800**	NS	NS	NS	NS	NS	NS	NS	NS
	Trichloroethene	**1/29/98 8,900**	NS	NS	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/29/98 3,000**	NS	NS	NS	NS	NS	NS	NS	NS
IR25MW20A	1,2-Dichloroethane	**1/29/98 2**	NS	NS	NS	NS	NS	NS	NS	NS
	Fluoride	**1/29/98 3,700**	NS	NS	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	**1/29/98 12**	NS	NS	NS	NS	NS	NS	NS	NS

Notes: Bold type indicates the concentration in groundwater exceeded the applicable screening criterion. For duplicate samples, the reported result is the maximum concentration.

µg/L Micrograms per liter
HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
NA Not analyzed
NS Not sampled
< Less than the analytical detection limit listed
[a] The concentration exceeded the most stringent MCL but was less than the HGAL.
[b] The analytical detection limit exceeds applicable screening criteria.
[c] Concentration of analyte was detected at the most stringent MCL.
[d] Sampling result collected as a grab sample.

TABLE 3

RESULTS FOR IR-28 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR28MW124A	Selenium	**5/20/94 50.1**	7/12/95 < 4.0	11/21/95 < 3.9	NS	NS	NS	NS
IR28MW125A	Chromium	**5/26/94 286**	6/12/95 NA	**6/13/95 177**	**12/4/95 250**	NS	NS	NS
	Trichloroethene	**5/26/94 9**	**6/12/95 8**	6/13/95 NA	**12/4/95 10**	NS	NS	NS
IR28MW126A	Aluminum	5/20/94 < 23.6	6/12/95 < 25.6	12/4/95 < 36.3 [d]	**12/4/95 2,250 [d]**	3/19/96 < 60.6	NS	NS
	Chromium	5/20/94 < 3.0	6/12/95 < 1.0	**12/4/95 88**	3/19/96 < 0.40	NS	NS	NS
	Lead	5/20/94 3.9	6/12/95 < 1.3	12/4/95 < 1.2[d]	**12/4/95 25.6[d]**	3/19/96 < 0.8	NS	NS
	Mercury	5/20/94 0.11	6/12/95 < 0.10	**12/4/95 3**	3/19/96 < 0.10	NS	NS	NS
	Nickel	5/20/94 < 13.8	6/12/95 < 5.0	**12/4/95 187**	3/19/96 5.0	NS	NS	NS
	Tetrachloroethene	**5/20/94 10**	**6/12/94 6**	**12/4/95 6**	3/19/96 4	NS	NS	NS
	Trichloroethene	**5/20/94 6**	6/12/94 5[c]	12/4/95 < 10[b]	3/19/96 4	NS	NS	NS
	Vinyl chloride	5/20/94 < 10[b]	6/12/95 < 10[b]	12/4/95 < 10[b]	**3/19/96 0.8**	NS	NS	NS
IR28MW127A	Aluminum	5/23/94 30.1	6/8/95 < 23.0	11/27/95 < 26[d]	**11/27/95 1,190[d]**	NS	NS	NS

TABLE 3 (Continued)

RESULTS FOR IR-28 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR28MW127A (cont.)	Antimony	5/23/94 6.1[a]	6/8/95 < 1.9	11/27/95 < 3.0	NS	NS	NS	NS
	Chromium	5/23/94 2.9	6/8/95 < 1.0	**11/27/95 71.6**	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**5/2/94 210 [e]**	5/23/94 NA	6/8/95 NA	11/27/95 NA	NS	NS	NS
	Mercury	5/23/94 < 0.9	6/8/95 < 0.1	**11/27/95 4.8**	NS	NS	NS	NS
	Lead	5/23/94 < 0.79	6/8/95 < 1.3	11/27/95 < 1.2[d]	**11/27/95 29.7[d]**	NS	NS	NS
	Nickel	5/23/94 < 5.9	6/8/95 4.2	**11/27/95 146**	NS	NS	NS	NS
	Tetrachloroethene	**5/23/94 380**	**6/8/95 240**	**11/27/95 300**	NS	NS	NS	NS
	trans-1,2-Dichloroethene	**5/2/94 40 [e]**	5/23/94 NA	6/8/95 NA	11/27/95 NA	NS	NS	NS
	Trichloroethene	**5/23/94 55**	**6/8/95 52**	**11/27/95 50**	NS	NS	NS	NS
IR28MW128A	Benzene	**5/25/94 22**	**6/13/95 37**	**12/5/95 29**	NS	NS	NS	NS
	Trichloroethene	**5/25/94 68**	**6/13/95 40**	**12/5/95 35**	NS	NS	NS	NS
	Vinyl chloride	**5/25/94 150**	**6/13/95 150**	**12/5/95 76**	NS	NS	NS	NS

TABLE 3 (Continued)

RESULTS FOR IR-28 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)
IR28MW129A	Aroclor-1260	5/31/94 < 0.5	**6/27/95** **23**	11/29/95 < 0.5	NS	NS	NS	NS
	Chromium	5/31/94 < 0.90	6/27/95 < 1.8	**11/29/95** **50.6**	NS	NS	NS	NS
	Nickel	5/31/94 < 4.9	6/27/95 5.0	**11/29/95** **117.8**	NS	NS	NS	NS
IR28MW136A	Benzene	6/8/94 < 100[b]	6/8/95 < 50[b]	**12/11/95** **9**	**1/28/98** **4**	NS	NS	NS
	cis-1,2-Dichloroethene	6/8/94 NA	6/8/95 NA	12/11/95 NA	**1/28/98** **250**	NS	NS	NS
	Tetrachloroethene	6/8/94 < 100[b]	6/8/95 < 50[b]	12/11/95 < 10[b]	**1/28/98** **11**	NS	NS	NS
	trans-1,2-Dichloroethene	6/8/94 NA	6/8/95 NA	12/11/95 NA	**1/28/98** **13**	NS	NS	NS
	Trichloroethene	6/8/94 < 100[b]	6/8/95 < 50[b]	**12/11/95** **11**	**1/28/98** **10**	NS	NS	NS
	Vinyl chloride	**6/8/94** **460**	**6/8/95** **550**	**12/11/95** **470**	**1/28/98** **220**	NS	NS	NS
IR28MW151A	Tetrachloroethene	**6/22/94** **15**	6/29/95 < 10[b]	12/12/95 < 50[b]	NS	NS	NS	NS
	Trichloroethene	**6/22/94** **500**	**6/29/95** **42**	**12/12/95** **700**	NS	NS	NS	NS
	Vinyl chloride	**6/22/94** **160**	**6/29/95** **330**	**12/12/95** **320**	NS	NS	NS	NS
IR28MW155A	Benzene	**5/31/94** **11**	**7/25/94** **7**	**6/13/95** **8**	11/29/95 < 10[b]	NS	NS	NS

TABLE 3 (Continued)

RESULTS FOR IR-28 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR28MW169A	1,4-Dichlorobenzene	**6/9/94** **6**	**6/22/95** **6**	**12/13/95** **14**	NS	NS	NS	NS
IR28MW171A	Aroclor-1260	**6/3/94** **2.9**	**6/9/95** **0.85**	11/20/95 0.41	NS	NS	NS	NS
IR28MW200A	Trichloroethene	6/6/94 < 10[b]	7/19/95 NA	**7/31/95** **6**	8/1/95 NA	11/20/95 2	NS	NS
IR28MW286A	Tetrachloroethene	11/17/95 4	11/17/95 4	2/2/96 < 10	4/4/95 5	NS	NS	NS
IR28MW290A	bis(2-Ethylhexyl)phthalate	11/15/95 < 10[b]	2/2/96 < 10[b]	**4/5/96** **49**	NS	NS	NS	NS
IR28MW293A	Thallium	**11/17/95** **13.9**	2/27/96 < 1.9	5/1/96 < 1.7	NS	NS	NS	NS
IR28MW294A	Aluminum	**11/17/95** **26,300**	2/27/96 < 19.1	5/7/96 142	NS	NS	NS	NS
	Chromium	**11/17/95** **267**	2/27/96 < 0.40	5/7/96 1.5	NS	NS	NS	NS
	Nickel	**11/17/95** **384**	2/27/96 5	5/7/96 7	NS	NS	NS	NS
IR28MW298A	Trichloroethene	**2/2/96** **8**	**4/5/96** **9**	**5/6/96** **8**	NS	NS	NS	NS
IR28MW311A	Benzo(a)pyrene	**4/19/96** **3**	5/28/96 < 10[b]	6/27/96 < 10[b]	NS	NS	NS	NS
	Heptachlor epoxide	4/19/96 < 0.01	5/28/96 < 0.01	**6/27/96** **0.03**	NS	NS	NS	NS
	Manganese	4/19/96 5,770	**5/28/96** **10,500**	6/27/96 2,560	NS	NS	NS	NS
	Trichloroethene	**4/19/96** **31**	**5/28/96** **53**	**6/27/96** **33**	NS	NS	NS	NS

TABLE 3 (Continued)

**RESULTS FOR IR-28 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA**

Monitoring Well	Analyte	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)
IR28MW324A	Benzene	**1/9/98 2[e]**	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/9/98 10[e]**	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/9/98 52[e]**	NS	NS	NS	NS	NS	NS
IR28MW325A	Benzene	**1//98 5[e]**	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/28/98 9[e]**	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/9/98 66[e]**	NS	NS	NS	NS	NS	NS
IR28MW326A	cis-1,2-Dichloroethene	**1/9/98 7[e]**	NS	NS	NS	NS	NS	NS
IR28MW327A	Benzene	**1/28/98 3**	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/28/98 130**	NS	NS	NS	NS	NS	NS
	Trichloroethene	**1/28/98 6**	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/28/98 110**	NS	NS	NS	NS	NS	NS
IR28MW328A	Benzene	**1/27/98 3**	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/27/98 58**	NS	NS	NS	NS	NS	NS

TABLE 3 (Continued)

RESULTS FOR IR-28 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR28MW328A (cont.)	Vinyl chloride	**1/27/98 86**	NS	NS	NS	NS	NS	NS
IR28MW329A	Benzene	**1/27/98 2**	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/27/98 91**	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	1/27/98 5[c]	NS	NS	NS	NS	NS	NS
	Trichloroethene	**1/27/98 6**	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/27/98 74**	NS	NS	NS	NS	NS	NS
IR28MW330A	Benzene	**1/28/98 2**	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/28/98 190**	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	**1/28/98 23**	NS	NS	NS	NS	NS	NS
	Trichloroethene	**1/28/98 8**	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/28/98 92**	NS	NS	NS	NS	NS	NS
IR28MW331A	Benzene	**1/28/98 3**	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/28/98 260**	NS	NS	NS	NS	NS	NS

TABLE 3 (Continued)

RESULTS FOR IR-28 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR28MW331A (cont.)	Tetrachloroethene	**1/28/98 39**	NS	NS	NS	NS	NS	NS
	Trichloroethene	**1/28/98 12**	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/28/98 130**	NS	NS	NS	NS	NS	NS
IR28MW333A	Benzene	1/26/98 1[c]	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/26/98 13**	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	**1/26/98 6**	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/26/98 13**	NS	NS	NS	NS	NS	NS
IR28MW334A	Benzene	**1/27/98 3**	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/27/98 510**	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	**1/27/98 24**	NS	NS	NS	NS	NS	NS
	trans-1,2-Dichloroethene	1/27/98 10[c]	NS	NS	NS	NS	NS	NS
	Trichloroethene	**1/27/98 13**	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/27/98 230**	NS	NS	NS	NS	NS	NS

TABLE 3 (Continued)

RESULTS FOR IR-28 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR28MW335A	Benzene	**1/26/98 2**	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/26/98 270**	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	**1/26/98 13**	NS	NS	NS	NS	NS	NS
	trans-1,2-Dichloroethene	1/26/98 10[c]	NS	NS	NS	NS	NS	NS
	Trichloroethene	**1/26/98 11**	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/26/98 120**	NS	NS	NS	NS	NS	NS
IR28MW336A	Benzene	**1/26/98 2**	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/26/98 460**	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	**1/26/98 23**	NS	NS	NS	NS	NS	NS
	trans-1,2-Dichloroethene	1/26/98 10[c]	NS	NS	NS	NS	NS	NS
	Trichloroethene	**1/26/98 14**	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/26/98 170**	NS	NS	NS	NS	NS	NS
IR28MW337A	Benzene	**1/28/98 2**	NS	NS	NS	NS	NS	NS

TABLE 3 (Continued)

RESULTS FOR IR-28 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)
IR28MW337A (cont.)	cis-1,2-Dichloroethene	**1/28/98 430**	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	**1/28/98 92**	NS	NS	NS	NS	NS	NS
	Trichloroethene	**1/28/98 19**	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/28/98 150**	NS	NS	NS	NS	NS	NS
IR28MW338A	cis-1,2-Dichloroethene	**1/26/98 74**[e]	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	**1/26/98 190**[e]	NS	NS	NS	NS	NS	NS
	Trichloroethene	**1/26/98 20**[e]	NS	NS	NS	NS	NS	NS
	Vinyl chloride	**1/26/98 18**[e]	NS	NS	NS	NS	NS	NS
IR28MW339A	Benzene	**1/9/98 3**[e]	**1/26/98 2**	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/9/98 620**[e]	**1/26/98 280**	NS	NS	NS	NS	NS
	Tetrachloroethene	**1/9/98 9**[e]	**1/26/98 6**	NS	NS	NS	NS	NS
	Trichloroethene	**1/9/98 10**[e]	**1/26/98 6**	NS	NS	NS	NS	NS
	Vinyl chloride	**1/9/98 140**[e]	**1/26/98 60**	NS	NS	NS	NS	NS

TABLE 3 (Continued)

RESULTS FOR IR-28 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR28MW340A	Benzene	**1/9/98** **3**[e]	**1/26/98** **3**	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**1/9/98** **72**[e]	**1/26/98** **78**	NS	NS	NS	NS	NS
	Vinyl chloride	**1/9/98** **19**[e]	**1/26/98** **12**	NS	NS	NS	NS	NS
PA28MW50A	Benzene	**2/22/93** **11**	**6/15/95** **5**	12/11/95 < 20[b]	NS	NS	NS	NS
	Tetrachloroethene	**2/22/93** **9**	**6/15/95** **14**	12/11/95 < 20[b]	NS	NS	NS	NS
	Trichloroethene	**2/22/93** **12**	**6/15/95** **24**	**12/11/95** **48**	NS	NS	NS	NS
	Vinyl chloride	**2/22/93** **140**	**6/15/95** **170**	**12/11/95** **85**	NS	NS	NS	NS
PA28MW51A	Benzene	**2/22/93** **9**	**6/15/95** **2**	12/11/95 < 10[b]	NS	NS	NS	NS
	bis(2-Ethylhexyl)phthalate	**2/22/93** **77**	6/15/95 < 4	12/11/95 < 4	NS	NS	NS	NS
PA28MW52A	Benzo(a)pyrene	**2/22/93** **2**	6/15/95 < 10[b]	12/13/95 < 10[b]	NS	NS	NS	NS
	Vinyl chloride	**2/22/93** **2**	6/15/95 < 10[b]	12/13/95 < 10[b]	NS	NS	NS	NS
PA50MW03A	Bis(2-Ethylhexyl)phthalate	3/17/93 <10[b]	**7/11/94** **99**	3/25/96 < 4	NS	NS	NS	NS
	Cadmium	**3/17/93** **6.2**	7/11/94 < 1.0	3/25/96 < 1.0	NS	NS	NS	NS

TABLE 3 (Continued)

RESULTS FOR IR-28 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR58MW31A	1,1,2,2-Tetrachloroethane	6/30/94 < 500[b]	7/1/94 NA	**6/20/95 6**	6/21/95 NA	11/28/95 < 200[b]	11/29/95 NA	1/23/98 < 10[b]
	1,1-Dichloroethane	5/12/94 < 5[e]	6/30/94 < 500[b]	6/20/95 5[c]	6/21/95 NA	11/28/95 < 200[b]	11/29/95 NA	1/23/98 < 10[b]
	1,1-Dichloroethene	6/30/94 < 500[b]	7/1/94 NA	**6/20/95 7**	6/21/95 NA	11/28/95 < 200[b]	11/29/95 NA	1/23/98 < 10[b]
	1,2-Dichlorobenzene	6/30/94 NA	**7/1/94 700**	6/20/95 NA	**6/21/95 610**	11/28/95 NA	11/29/95 540	**1/23/98 3,300**
	1,4-Dichlorobenzene	6/30/94 NA	**7/1/94 320**	6/20/95 NA	**6/21/95 170**	11/28/95 NA	**11/29/95 160**	**1/23/98 760**
	Aroclor-1260	6/30/94 NA	7/1/94 < 0.5	6/20/95 NA	**6/21/95 3.4**	11/28/95 NA	**11/29/95 3.6**	1/23/98 NA
	Benzene	6/30/94 < 500[b]	7/1/94 NA	**6/20/95 12**	6/21/95 NA	11/28/95 < 200[b]	11/29/95 NA	**1/23/98 10**
	Chlorobenzene	6/30/94 < 500[b]	7/1/94 NA	**6/20/95 110**	6/21/95 NA	**11/28/95 250**	11/29/95 NA	**1/23/98 230**
	cis-1,2-Dichloroethene	6/30/94 NA	7/1/94 NA	6/20/95 NA	6/21/95 NA	11/28/95 NA	11/29/95 NA	**1/23/98 3,600**
	Tetrachloroethene	**5/12/95 10**	6/30/94 <500	6/20/95 <10	11/28/95 <200	1/23/98 <10	NS	NS
	Vinyl chloride	6/30/94 < 500[b]	7/1/94 NA	**6/20/95 480**	6/21/95 NA	**11/28/95 580**	11/29/95 NA	**1/23/98 800**

TABLE 3 (Continued)

RESULTS FOR IR-28 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Notes: Bold type indicates that the concentration in groundwater exceeded the applicable screening criterion. For duplicate samples, the reported result is the maximum concentration .

µg/L	Micrograms per liter
HGAL	Hunters Point groundwater ambient level
MCL	Maximum contaminant level
NA	Not analyzed
NS	Not sampled
<	Less than the analytical detection limit listed
a	The concentration exceeded the most stringent MCL but was less than the HGAL.
b	The analytical detection limit exceeds applicable screening criteria.
c	Concentration of analyte was detected at the most stringent MCL.
d	Duplicate sample result conflicted with primary sample result; one result exceeded applicable screening criteria, and other result was either non-detect or detected below applicable screening criteria.
e	Sampling result collected as a grab sample.

TABLE 4

RESULTS FOR IR-28 B-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR28MW314B	Benzene	5/3/96 1[a]	6/5/96 0.3	7/3/96 1[a]
	Vinyl chloride	**5/3/96 38**	**6/5/96 16**	**7/3/96 58**
IR58MW32B	Tetrachloroethene	**4/17/96 24**	**5/22/96 28**	**6/24/96 21**
	Trichloroethene	**4/17/96 8**	**5/22/96 7**	6/24/96 5[a]
	Vinyl chloride	**4/17/96 1**	**5/22/96 1**	6/24/96 < 0.5
IR58MW33B	1,1-Dichloroethane	4/17/96 < 2	**5/23/96 7**	6/24/96 < 1
	1,2-Dichloropropane	4/17/96 < 2	**5/23/96 6**	6/24/96 < 1
	1,4-Dichlorobenzene	**4/17/96 44**	**5/23/96 40**	**6/24/96 46**
	Benzene	4/17/96 1[a]	**5/23/96 6**	6/24/96 < 1
	Carbon tetrachloride	4/17/96 < 2[b]	**5/23/96 3**	6/24/96 < 1[b]
	Tetrachloroethene	**4/17/96 6**	**5/23/96 10**	6/24/96 5[a]
	Trichloroethene	**4/17/96 7**	**5/23/96 15**	**6/24/96 9**
	Vinyl chloride	**4/17/96 84**	**5/23/96 91**	**6/24/96 38**

TABLE 4 (Continued)

RESULTS FOR IR-28 B-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Notes: Bold type indicates that the concentration in groundwater exceeded the applicable screening criterion. For duplicate samples, the reported result is the maximum concentration.

µg/L	Micrograms per liter
HGAL	Hunters Point groundwater ambient level
MCL	Maximum contaminant level
<	Less than the analytical detection limit listed
[a]	Concentration of analyte was detected at the most stringent MCL.
[b]	The analytical detection limit exceeds applicable screening criteria.

TABLE 5

RESULTS FOR IR-28 BEDROCK WATER-BEARING ZONE MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR28MW172F	Thallium	11/22/94 < 2.0	**6/26/95 2.4**	12/7/95 < 1.9	NS	NS	NS	NS	NS	NS
IR28MW188F	Carbon tetrachloride	**6/28/94 14**	**6/19/95 15**	**12/4/95 17**	12/5/95 NA	NS	NS	NS	NS	NS
IR28MW189F	Trichloroethene	**6/30/94 12**	7/1/94 NA	**6/19/95 14**	6/20/95 NA	**12/4/95 11**	12/5/95 NA	NS	NS	NS
IR28MW190F	Carbon tetrachloride	**6/30/94 17**	7/1/94 NA	**6/26/95 12**	**11/20/95 18**	NS	NS	NS	NS	NS
	Trichloroethene	**6/30/94 10**	7/1/94 NA	**6/26/95 7**	**11/20/95 9**	NS	NS	NS	NS	NS
IR28MW201F	Thallium	**12/7/94 3.3**	6/22/95 NA	6/23/95 < 2.0	11/27/95 NA	11/28/95 < 3.4[a]	NS	NS	NS	NS
IR28MW211F	1,2-Dichloroethane	7/6/94 < 1,000[a]	7/7/94 NA	6/27/95 < 2,500[a]	6/28/95 NA	10/27/95 < 1,000[a]	12/11/95 < 1,000[a]	12/12/95 NA	3/20/96 < 25[a]	**2/3/98 36**
	1,1,2-Trichloroethane	7/6/94 < 1,000[a]	7/7/94 NA	6/27/95 < 2,500[a]	6/28/95 NA	10/27/95 < 1,000[a]	12/11/95 < 1,000[a]	12/12/95 NA	**3/20/96 39**	**2/3/98 34**
	Carbon tetrachloride	7/6/94 < 1,000[a]	7/7/94 NA	6/27/95 < 2,500[a]	6/28/95 NA	10/27/95 < 1,000[a]	12/11/95 < 1,000[a]	12/12/95 NA	**3/20/96 38**	**2/3/98 100**
	cis-1,2-Dichloroethene	7/6/94 NA	7/7/94 NA	6/27/95 NA	6/28/95 NA	10/27/95 NA	12/11/95 NA	12/12/95 NA	3/20/96 NA	**2/3/98 48**
	Chloroform	7/6/94 < 1,000[a]	7/7/94 NA	6/27/95 < 2,500[a]	6/28/95 NA	10/27/95 < 1,000[a]	12/11/95 < 1,000[a]	12/12/95 NA	**3/20/96 260**	**2/3/98 580**

TABLE 5 (Continued)

RESULTS FOR IR-28 BEDROCK WATER-BEARING ZONE MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR28MW211F (cont.)	Tetrachloroethene	7/6/94 < 1,000[a]	7/7/94 NA	6/27/95 < 2,500[a]	6/28/95 NA	10/27/95 < 1,000[a]	12/11/95 < 1,000[a]	12/12/95 NA	3/20/96 4	**2/3/98 36**
	Trichloroethene	**7/6/94 19,000**	7/7/94 NA	**6/27/95 40,000**	6/28/95 NA	**10/27/95 61,000**	**12/11/95 18,000**	12/12/95 NA	**3/20/96 10,000**	**2/3/98 15,000**
IR28MW255F	Thallium	7/18/94 NA	**7/19/94 3.0**	7/26/95 < 10.0[a]	7/31/95 NA	8/1/95 NA	11/27/95 NA	11/28/95 < 2.8[a]	NS	NS
IR28MW273F	Trichloroethene	**3/1/96 7**	**5/6/96 24**	**6/17/96 23**	NS	NS	NS	NS	NS	NS
IR28MW275F	Carbon tetrachloride	**11/21/95 0.8**	2/2/96 < 10[a]	4/5/96 < 0.5	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	**11/21/95 30**	2/2/96 < 10[a]	**4/5/96 33**	NS	NS	NS	NS	NS	NS
	Trichloroethene	**11/21/95 130**	2/2/96 < 10[a]	**4/5/96 74**	NS	NS	NS	NS	NS	NS
IR28MW300F	Carbon tetrachloride	**3/1/96 17**	**5/8/96 11**	**6/19/96 14**	NS	NS	NS	NS	NS	NS
	Trichloroethene	**3/1/96 40**	**5/8/96 27**	**6/19/96 33**	NS	NS	NS	NS	NS	NS
IR28MW310F	Carbon tetrachloride	**4/22/96 4**	**5/28/96 8**	**7/2/96 6**	NS	NS	NS	NS	NS	NS
	Trichloroethene	**4/22/96 34**	**5/28/96 64**	**7/2/96 58**	NS	NS	NS	NS	NS	NS
IR28MW312F	Carbon tetrachloride	4/19/96 0.4	5/28/96 0.2	**7/2/96 0.6**	NS	NS	NS	NS	NS	NS
	Trichloroethene	**4/19/96 16**	**5/28/96 8**	**7/2/96 20**	NS	NS	NS	NS	NS	NS

TABLE 5 (Continued)

RESULTS FOR IR-28 BEDROCK WATER-BEARING ZONE MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR28MW341F	1,2-Dichloroethane	**2/3/98 3**	NS	NS	NS	NS	NS	NS	NS	NS
	cis-1,2-Dichloroethene	**2/3/98 22**	NS	NS	NS	NS	NS	NS	NS	NS
	Carbon tetrachloride	**2/3/98 44**	NS	NS	NS	NS	NS	NS	NS	NS
	Chloroform	**2/3/98 180**	NS	NS	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	**2/3/98 18**	NS	NS	NS	NS	NS	NS	NS	NS
	Trichloroethene	**2/3/98 2,900**	NS	NS	NS	NS	NS	NS	NS	NS
IR28MW342F	cis-1,2-Dichloroethene	**2/3/98 10**	NS	NS	NS	NS	NS	NS	NS	NS
	Carbon tetrachloride	**2/3/98 11**	NS	NS	NS	NS	NS	NS	NS	NS
	Tetrachloroethene	**2/3/98 46**	NS	NS	NS	NS	NS	NS	NS	NS
	Trichloroethene	**2/3/98 930**	NS	NS	NS	NS	NS	NS	NS	NS

TABLE 5 (Continued)

RESULTS FOR IR-28 BEDROCK WATER-BEARING ZONE MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA PARCEL C GROUNDWATER TECHNICAL MEMORANDUM HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Notes: Bold type indicates that the concentration in groundwater exceeded the applicable screening criterion. For duplicate samples, the reported result is the maximum concentration.

µg/L	Micrograms per liter
HGAL	Hunters Point groundwater ambient level
MCL	Maximum contaminant level
NA	Not analyzed
NS	Not sampled
<	Less than the analytical detection limit listed
[a]	The analytical detection limit exceeds applicable screening criteria.

TABLE 6

RESULTS FOR IR-29 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR28MW48A	Aroclor-1248	**6/6/94** **1.9**	8/2/95 < 0.5	11/27/95 < 0.5
PA50MW04A	bis(2-Ethylhexyl)phthalate	3/18/93 < 11[a]	**6/7/94** **64**	3/26/96 < 4

Notes: Bold type indicates that the concentration in groundwater exceeded the applicable screening criterion. For duplicate samples, the reported result is the maximum concentration.

µg/L Micrograms per liter
HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
< Less than the analytical detection limit listed
a The analytical detection limit exceeds applicable screening criteria.

TABLE 7

RESULTS FOR IR-29 BEDROCK WATER-BEARING ZONE MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL C GROUNDWATER TECHNICAL MEMORANDUM
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR29MW58F	Thallium	11/28/94 NA	**11/29/94** **4.1**	6/19/95 NA	**6/20/95** **5.2**	11/29/95 < 5.2[a]
IR29MW72F	Antimony	**7/25/94** **22.5**	6/21/95 NA	6/22/95 < 9.6[a]	12/7/95 5.3	NS
	Benzene	**7/25/94** **4**	6/21/95 < 10[a]	12/6/95 < 10[a]	NS	NS
	Chromium	**7/25/94** **55**	6/21/95 NA	**6/22/95** **195**	**12/7/95** **101**	NS
IR29MW85F	Antimony	4/22/96 NA	**4/23/96** **10.4**	5/23/96 NA	**5/24/96** **9.0**	**7/8/96** **6.4**
IR50MW13F	Aroclor-1260	**9/7/94** **1.3**	6/16/95 < 0.5	12/6/95 < 0.5	NS	NS
	Thallium	**9/7/94** **2.2**	6/16/95 < 1.5	12/6/95 < 9.5[a]	NS	NS

Notes: Bold type indicates that the concentration in groundwater exceeded the applicable screening criterion. For duplicate samples, the reported result is the maximum concentration.
µg/L Micrograms per liter
HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
NA NS analyzed
NS NS
< Less than the analytical detection limit listed
a The analytical detection limit exceeds applicable screening criteria.

TABLE 8

RESULTS FOR IR-58 BEDROCK WATER-BEARING MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA PARCEL C GROUNDWATER TECHNICAL MEMORANDUM HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)	Sampling Date Result (μg/L)
IR58MW25F	Chromium	**7/12/94 60.6**	**6/21/95 60.8**	**12/5/95 63.1**

Notes: Bold type indicates that the concentration in groundwater exceeded the applicable screening criterion. For duplicate samples, the reported result is the maximum concentration.

μg/L Micrograms per liter
HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
NA Not analyzed
< Less than the analytical detection limit listed

TABLE 9

RESULTS FOR IR-64 A-AQUIFER MONITORING WELL GROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA PARCEL C GROUNDWATER TECHNICAL MEMORANDUM HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Monitoring Well	Analyte	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)	Sampling Date Result (µg/L)
IR64MW05A	Thallium	11/17/95 NA	11/20/95 3.6[a]	3/5/96 < 1.9	5/9/96 NA
	Vinyl chloride	11/17/95 < 0.5	11/20/95 NA	**3/5/96** **1**	5/9/96 0.4

Notes: Bold type indicates that the concentration in groundwater exceeded the applicable screening criterion. For duplicate samples, the reported result is the maximum concentration.

µg/L Micrograms per liter
HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
NA Not analyzed
< Less than the analytical detection limit listed
[a] The concentration exceeded the most stringent MCL but was less than the HGAL.

APPENDIX B

RESPONSES TO REGULATORY AGENCY COMMENTS

DEPARTMENT OF THE NAVY
SOUTHWEST DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132-5190

5090
Ser 06CH.RM/517
July 10, 2000

Ms. Sheryl Lauth (SFD 8-1)
Ms. Claire Trombadore (SFD 8-1)
U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street
San Francisco, CA 94105

Mr. Chein Kao
Department of Toxic Substances Control
700 Heinz Avenue
Bldg. F, Suite 200
Berkeley, CA 94710-2737

Mr. Brad Job
California Regional Water Quality Control Board, San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

Dear BCT Members:

Enclosure (1) is provided for your review regarding the response to comments for the Draft Field Sampling Plan (FSP) and the Draft Quality Assurance Project Plan (QAPP) for the Phase I Groundwater Data Gaps Investigation at Hunters Point Shipyard (HPS). The Navy would like to discuss these responses to comments at the July 13, 2000 BCT meeting to allow completion of the final FSP/QAPP which is due July 25, 2000.

Should you have any questions concerning this matter, please contact the undersigned at (619) 532-0913.

Sincerely,

RICHARD G. MACH JR., P.E.
BRAC Environmental Coordinator
By direction of the Commander

Enclosure: (1) Response to comments from

- U.S. Environmental Protection Agency Quality Assurance Office, June 19, 2000
- Response to comments from U.S. Environmental Protection Agency (Parcel C), June 13, 2000
- Response to comments from U. S. Environmental Protection Agency (Parcel D), June 20, 2000
- Department of Toxic Substances Control, June 23, 2000
- Regional Water Quality Control Board, June 16, 2000

HUNTERS POINT SHIPYARD
DRAFT FIELD SAMPLING PLAN
FOR PHASE I GROUNDWATER DATA GAPS INVESTIGATION
RESPONSE TO COMMENTS
FROM U.S. ENVIRONMENTAL PROTECTION AGENCY (PARCEL C)

This document presents the Navy's responses to comments from the U.S. Environmental Protection Agency (EPA) on the draft Field Sampling Plan (FSP) for the Phase I Groundwater Data Gaps Investigation (PGDGI) for Hunters Point Shipyard (HPS), San Francisco, California, dated June 1, 2000. The comments addressed below, which are specific to Parcel C at HPS, were received from EPA on June 13, 2000.

RESPONSES TO EPA

General Comments

1. **Comment:** **Please explain briefly how the water level and water quality data will be reported and incorporated into the Feasibility Study.**

   Response: A new section will be added to the FSP to discuss reporting of the PGDGI results. In particular, water level and water quality data gathered from the PGDGI will be presented to the Base Realignment and Closure (BRAC) Cleanup Team (BCT) in an information package similar to the package provided for the working meetings conducted in February and March 2000. The BCT's evaluation of that information will be incorporated into the revised feasibility study (FS) for Parcel C. In addition, following the completion of Phase II of the groundwater data gaps investigation, the groundwater areas proposed for evaluation in the FS will be specified in a beneficial use letter.

2. **Comment:** **The beneficial use analysis referenced in Table 4-5 should be discussed as part of Section 2.0.**

   Response: Section 2.0 will be revised to elaborate on the beneficial use analysis referred to in Table 4-5.

3. **Comment:** **It would be helpful to have one additional figure that included both the wells proposed for re-sampling and installation for easier reference.**

   Response: In the information package to be submitted following the PGDGI, the Navy will provide a drawing(s) that includes both pieces of information. The information is currently provided on two figures because the well re-sampling and well installation activities are to be conducted by separate field teams. If both sets of information were presented on one figure, that figure would become difficult for the field sampling and well installation teams to decipher.

4. **Comment:** **We would suggest that once the water level data have been interpreted and groundwater gradients confirmed, the BCT briefly revisit the well re-sampling/installation locations to ensure that groundwater samples are collected in the appropriate locations for adequate plume definition**

Response: The PGDGI is designed to obtain data during the first sampling event (Phase I), and incorporate it for consideration during the Phase II sampling. Because of the time constraints of the initial sampling phase, it will not be feasible to evaluate the water level data before the initial sampling event.

5. **Comment:** **Please reference the possibility of a Phase II investigation mentioned during the scoping meetings and how this data may be incorporated into the overall groundwater strategy, if collected.**

Response: The second round of sampling (during the "dry season") will be performed. This sampling event will essentially constitute the Phase II investigation. The second sampling event will incorporate the data gathered during the first sampling event; the number of monitoring wells may increase or decrease as an evaluation of the initial data indicates is appropriate. The second sampling event will be evaluated and incorporated into the FS.

Specific Comments

1. **Comment:** **Please clarify whether new wells will be installed in sufficient time to be included in the first water level data collection round. In many cases, particularly when B-aquifer wells are to be installed, it would be helpful to include these wells in the water level measurements. For example, in IR-28 there are only four B-aquifer wells selected for water level measurements, but nine new B-aquifer wells will be installed, more than tripling the amount of data that could be available. Similarly, there are no B-aquifer wells in IR-25, but three will be installed.**

Response: Because of the time constraints of the initial sampling phase, it will not be feasible to install the new B-aquifer wells before the water level measurement event; however, upon completion of the new B-aquifer wells water level measurements will be conducted at all B-aquifer wells.

2. **Comment:** **Is it possible to redevelop IR06MW45A before water levels are taken so that it can be included in the water level measurement group? Inclusion of this well would give a more complete picture of the water table in the vicinity of IR-25, since there are no nearby wells to the east and southeast.**

Response: Well IR06MW45A has been redeveloped and will be included in the water level measurement event. In addition, water level measurements will also be conducted at wells IR06MW22A and IR06MW32A (recently re-installed to gather additional data for the total petroleum hydrocarbon corrective action plan) and at well IR20MW17A to provide additional data in the vicinity of IR-25.

3. **Comment:** **Very little water level data will be collected from the area within RU-C1, although water levels will be collected from wells around this RU. There are many wells that need to be surveyed in this area. Some of them, like RI28MW33A, IR28MW340A, IR28MW338A and IR28MW324A should be surveyed and included in the water level measurement group.**

Response: The wells identified above, with the exception of RI28MW33A that is an unknown well identification, are all ¾inch-diameter groundwater monitoring points installed during the 1998 treatability study. These wells, as well as well IR28MW333A, will be re-surveyed and will be included in the water level measurement event. In addition, water level measurements will be conducted at wells IR28MW151A and IR28MW170A to provide additional data in the vicinity of RU-C1.

4. **Comment:** **Since PCBs are a concern in IR-25, and PCBs would be more likely to be found in product than in water, the Navy should consider sampling the product in IR25MW11A and IR25MW22A for PCB analysis. These samples should be collected without purging the wells.**

Response: Product will be sampled from monitoring wells IR25MW11A and IR25MW22A and analyzed for polychlorinated biphenyls prior to any purging activities.

5. **Comment:** **Figures 4-1 and 4-2. Some of the wells are not labeled. For example, there is a black dot indicating an A-aquifer well on either side of IR28MW155A that do not have labels. Are these actual wells? If so, it is unclear why well IR28MW155A was selected for sampling and not one of these other wells, particularly since the eastern dot appears to be closer to the well with product (IR28MW129A).**

Response: The two black dots on either side of IR28MW155A on Figures 4-1 and 4-2 are piezometers, not actual wells. Well IR28MW155A is considered more appropriate for sampling than the nearby piezometers. The figure will be revised to remove the piezometer locations.

6. **Comment:** **Since one of the objectives for sampling IR29MW57A is to confirm the extent of RU-C4 and RU-C7, it is unclear why VOC analysis is not included.**

Response: Volatile organic compound analysis will be added to the analysis suite for IR29MW57A.

HUNTERS POINT SHIPYARD
DRAFT FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN
FOR PHASE I GROUNDWATER DATA GAPS INVESTIGATION
RESPONSE TO COMMENTS
FROM U.S. ENVIRONMENTAL PROTECTION AGENCY (PARCEL D)

This document presents the Navy's responses to comments from the U.S. Environmental Protection Agency (EPA) on the Draft Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) for the Phase I Groundwater Data Gaps Investigation (PGDGI), Hunters Point Shipyard (HPS), San Francisco, California, dated June 1, 2000. The comments addressed below, which are specific to Parcel D at HPS, were received from EPA on June 20, 2000.

RESPONSES TO EPA

GENERAL COMMENTS – OVERALL

1. **Comment:** **EPA would like to reiterate that total dissolved solids (TDS) and yield data acquired during the Parcel D remedial investigation (RI) are available for A-aquifer groundwater on Parcel D. EPA believes that this data is sufficient to determine the portions of the A-aquifer on Parcel D that meet the definition of a potential drinking water source per Federal and state criteria. While it is prudent to resample RI monitoring wells and to fill data gaps for Parcel D groundwater, EPA is concerned that this effort will further delay the remedial action for Parcel D**

   Response: Under the current Federal Facility Agreement (FFA) schedule (currently under review by the regulatory agencies), the groundwater data gaps investigation will not delay the revised feasibility study at Parcel D. The critical path to reach the Parcel D revised feasibility study (FS) is the time-critical removal action for soil remediation areas, steam lines, and fuel lines at Parcel D.

2. **Comment:** **In the schedule presented in Table 8-1 of the FSP, there is no mention of a letter memorandum or other deliverable by which the Navy makes determinations of potential drinking water sources on Parcels C and D per Federal and state criteria. EPA has requested such a deliverable(s) be submitted by the Navy prior to the Navy's completion of the revised feasibility studies for Parcels C and D.**

   Response: The Navy will submit a beneficial use analysis letter to the Base Realignment and Closure (BRAC) Cleanup Team (BCT) following the Phase II data gaps investigation, which will include a second round of sampling. The current submittal date for the letter is January 18, 2001, more than 6 and 12 months, respectively, before the current completion dates for the revised FSs for Parcels D and C.

3. **Comment:** **Did the previously completed inspections of the existing RI monitoring wells include video logging? Please clarify.**

   Response: Video logging was not included in the well inspection activities. Details of well inspection activities are provided on page 4 of the FSP.

4. **Comment:** **Please include the meeting minutes referenced in text in the list of references for the FSP and the QAPjP. The Navy should also consider including the actual meeting minutes in appendices. In this way there will a clear record in one location of the objectives and scope of the groundwater data gaps sampling effort.**

Response: The meeting minutes discussed in the text will be included in the list of references for both the FSP and the QAPP, and Appendix D, to be added to the FSP, will provide copies of the meeting minutes.

5. **Comment:** **The title of the FSP and QAPjP reference only Parcels C and D but upon review of the documents, monitoring wells on Parcels B and E appear to be included in the groundwater data gaps sampling effort. Please clarify.**

Response: To clarify, the titles of the FSP and the QAPP do not make reference to any specific parcel at HPS; however, the focus of the investigation is on Parcels C and D. Additional wells in Parcels B and E have been included in the investigation for water level measurement to assess basewide groundwater flow patterns. In addition, installation of several wells at Parcel B is proposed to aid in the delineation of groundwater contamination in the vicinity of IR-25 (Parcel C).

6. **Comment:** **How did the Navy select the number and locations of the B-aquifer monitoring wells for Parcel D? EPA is concerned that there may not be enough coverage of the portions of Parcel D where the bay mud aquitard is absent. Please clarify.**

Response: B-aquifer locations were selected on the basis of a review of analytical results, geology, and groundwater flow. Wells are located to intercept potential contamination, as indicated by the geology and direction of A-aquifer groundwater flow. The data quality objectives (DQO) include the rationale for B-aquifer well locations; the Navy believes that the proposed number of well locations is sufficient for the Phase I investigation. The text of the FSP (page 8) will be revised to direct the reader to the QAPP for additional information about well locations. If Phase I data indicate that A-aquifer contamination has migrated to the B-aquifer and has not been adequately characterized, additional sampling locations will be proposed for the Phase II investigation.

7. **Comment:** **Please clarify that the Remedial Unit for Parcel D groundwater (RU-D1) per Figure 4-3 does not necessarily represent one large plume and that it was proposed by the Navy at one of the groundwater working meetings and not in the RI for Parcel D.**

Response: Figures 4-3 and 4-5 will be revised to indicate that the Parcel D remedial unit RU-D1 does not necessarily represent one large plume, but is an area having point exceedances that are proposed for further evaluation. RU-D1 was proposed by the Navy at a groundwater meeting on March 16, 2000.

GENERAL COMMENTS – FIELD SAMPLING PLAN

1. **Comment:** **The Draft Field Sampling Plan, Phase 1 Groundwater Data Gaps Investigation, Hunters Point Shipyard (the FSP) does not provide a specific discussion of the deficiencies or gaps in previous site characterizations that have created the need for this data gaps investigation. While some information regarding previous investigation activities at the different IR sites is presented in the Draft Quality Assurance Project Plan, Phase 1 Groundwater Data Gaps Investigation, Hunters Point Shipyard (the QAPjP), this information is insufficient to evaluate if the proposed field activities are sufficient to address the identified data gaps for each of the IR sites, or each of the groundwater plumes. Please revise the FSP to provide a discussion of the deficiencies or gaps in the past investigations performed at the different IR sites in order to facilitate an evaluation of the adequacy of the proposed data gaps investigation tasks.**

   Response: Section 2.0 of the FSP will be revised to include a discussion of the need for the data gaps investigation. A similar discussion was included in Section A1.4.1 of the QAPP.

2. **Comment:** **Information regarding the objectives of the proposed data gaps investigation and background for the investigation has not been included in the FSP, but instead has been presented in the QAPjP. Consequently, it is necessary to read both documents in order to understand the nature and extent of the proposed field sampling program. While it may be appropriate to present this information in the QAPjP, it should also be presented in the FSP, to provide both the reader and field personnel with a better understanding of the project. Please revise the FSP to include information regarding the background and objectives for the proposed investigation.**

   Response: Background information about the rationale for the collection of more data has been added to Section 2.0 of the FSP, as indicated in the Navy's response to specific comment 1. However, since the QAPP supplements the FSP, as is stated in Section 1.0 of the FSP, the Navy believes that it is duplicative to include extensive background information in both documents. Field crews are expected to have both the FSP and the QAPP on hand at all times, and the final version of the FSP and QAPP will be placed together in the same binder.

3. **Comment:** **The FSP does not discuss reporting or documentation of the findings of the proposed field activities. While Section 6.3 of the FSP discusses field documentation and input to a database, there is no mention of a report documenting the results and conclusions from the investigation, and there is no mention of any deliverables to the regulatory agencies. Please revise the FSP to include provisions for documentation and reporting of field activities and findings**

Response: A new section will be added to the FSP to discuss reporting of the PGDGI results. In particular, water level and water quality data gathered from the PGDGI will be presented to the BCT in an information package similar to the package provided for the working meetings conducted in February and March 2000. The BCT's evaluation of that information will be incorporated into the revised feasibility study (FS) for Parcel D. In addition, following the completion of Phase II of the groundwater data gaps investigation, the groundwater areas proposed for evaluation in the FS will be specified in a beneficial use letter.

4. **Comment:** **As part of the water level measurement program for the A-aquifer, water levels will be measured in 177 A-zone monitoring wells, in order to generate a more up-to date groundwater elevation contour map for the A-aquifer. However, top of casing (TOC) measurements will only be collected at 10 of these wells to confirm that the existing TOC measurements are accurate. This is less than 10 percent of the wells being included in the water level measurement program. Given that the objective of the water level measurement program is to generate the first basewide groundwater elevation contour map for the A-aquifer in over 4 years, and the importance of accurate TOC measurements for generating these groundwater elevation contours, confirming the TOC data at only 10 wells does not seem to be adequate assurance that the existing TOC measurements are accurate. Please revise the FSP to indicate that TOC measurements will be collected from at least 20 monitoring wells, to confirm that the existing measurements are accurate.**

Response: Although TOC elevations are not expected to change, the Navy has proposed to verify the elevations as a precautionary measure. To be particularly conservative, the Navy agrees to double the number of wells to be surveyed to 20. The text, tables, and figures of the FSP have been revised to reflect the change.

SPECIFIC COMMENTS – FIELD SAMPLING PLAN

1. **Comment:** **Section 2.0, Purpose and Objective, Page 2: Objective two listed in this section is to measure basewide water levels to determine the piezometric surface at existing A- and B-aquifer wells. However, the Step 2 (Identify the Decision) data quality objective (DQO) for this task listed in the QAPjP is to determine what is the current potentiometric surface of the A-aquifer, and it is further stated in the DQO section that water level measurements will be collected from approximately 177 existing A-aquifer locations. Please revise the FSP to clarify if the objective of this task is to evaluate only the A-aquifer potentiometric surface, or if the B-aquifer potentiometric surface will also be evaluated as part of this task. Additionally, please clarify how many of the 177 monitoring wells proposed for water level measurements are in the A-aquifer, and how many are in the B-aquifer. Finally, please ensure that the objectives listed in the FSP are consistent with the objectives listed in the QAPjP.**

Response: Step 2 in Section 2.0 of the FSP will be revised to distinguish the basewide water level measurements to be collected at the A-aquifer and B-aquifer wells, as consistent with the presentation in the QAPP. In particular, water level measurements will be collected at 189 A-aquifer wells and 19 B-aquifer wells basewide. In addition, a second B-aquifer water level measurement event will be conducted upon completion of the B-aquifer well installation activities and will include a total of 39 B-aquifer wells. Please note that the number of wells for water level measurements has been increased in response to comments provided by the BCT at the June 29, 2000 meeting.

2. **Comment:** **Section 2.0, Purpose and Objective, Page 2: Objective three listed in this section is to perform additional characterization of B-aquifers in Parcels C and D by sampling existing and newly-installed wells for hydrogeologic and chemical parameters. While the analytes of concern for the different wells are listed in Tables 4-4 and 4-5, there is no explanation in the FSP regarding what is meant by hydrogeologic parameters. Please revise the FSP to identify the hydrogeologic parameters that are to be investigated, the locations at which these parameters will be measured, the methodology for measuring and interpreting these parameters and the intended application of the data.**

Response: Section 2.0 will be revised to indicate that the following hydrogeologic parameters will be evaluated at the B-aquifer wells: yield, porosity, permeability, horizontal gradient, and vertical gradient. In addition, Section 4.0 (and the associated figures and tables) will be revised to specify the locations and methodology for collecting the hydrogeologic parameters as follows.

Yield: Section 4.5 will be revised to indicate that well development logs for the newly installed B-aquifer wells will be used to provide a preliminary assessment of whether the wells will meet the federal or state yield criteria. If the results indicate that the wells will not meet the yield criteria, a more detailed assessment will be conducted as part of Phase II.

Porosity and Permeability: Section 4.4 will be revised to indicate that a single soil sample will be collected from each new B-aquifer well at a depth within the well screen interval. The soil sample will be analyzed for effective porosity and hydraulic conductivity by American Petroleum Institute (API) Method RP40 and American Society for Testing and Materials (ASTM) Method D5084, respectively.

Horizontal and Vertical Gradient: Section 4.2 will be revised to indicate that water level measurements from B-aquifer wells will be used to determine horizontal gradient. In addition, water level measurements from selected B-aquifer wells with adjacent A-aquifer wells—coupled with salinity measurements from each well—will be used to determine vertical gradient.

3. **Comment:** **Section 4.2, Water Level Measurement, Page 5: The first sentence on this page indicates that water levels will be measured at all wells identified for the basewide water level measurement, in accordance with the schedule presented in Section 8.0. However, Section 8.0 only refers to Table 8-1, and Table 8-1 does not contain any information regarding the schedule for the collection of water level data. Please revise the FSP to provide information regarding the schedule for water level measurement as part of this investigation.**

Response: Table 8-1 will be revised to include a line item for water level measurements and to more accurately reflect the currently anticipated schedule.

4. **Comment:** **Section 4.2, Water Level Measurement, Page 6: The last paragraph of this section indicates that TOC elevations at 10 select wells will be measured to confirm previous survey measurements. However, the FSP does not discuss the criteria these data will be evaluated against, under what conditions corrective action will be taken, nor the nature of a corrective action response, if the new survey measurements do not agree with previous measurements. Page A-14 of the QAPjP (Section A1.4.5) describes the decision rules for the water level measurement study, the evaluation criteria, the criteria for corrective action and the type of corrective action that will be applied to the survey measurement data. Please revise the FSP to include information regarding the evaluation criteria, the criteria for corrective action and the type of corrective action that will be applied to the survey measurement data.**

Response: Section A1.4.5 of the QAPP states the decision rules for how to evaluate top of casing elevations at the 20 wells proposed for the confirmation land survey. Since the QAPP supplements the FSP, as is stated in Section 1.0 of the FSP, the Navy believes that it is not necessary to include duplicative information in the two documents. Field crews are expected to have both the FSP and the QAPP on hand at all times, and the final version of the FSP and QAPP will be placed together in the same binder.

5. **Comment:** **Section 4.3.2, Initial Measurement of Organic Vapor and Dissolved Oxygen, Page 6: The FSP discusses the measurement of dissolved oxygen at three intervals within the water column in the wells to be sampled. Typically, dissolved oxygen is measured once in each well, or once at each discretely screened interval. The FSP does not explain the rationale behind taking three measurements within one water column. Please revise the FSP to explain the rationale behind the proposal to measure dissolved oxygen at three intervals within one water column.**

Response: Section 4.3.2 will be revised to indicate that dissolved oxygen measurements are being collected at three separate intervals within the water column in an effort to quantify vertical variations for the evaluation of natural attenuation and for plume characterization.

6. **Comment:** **Section 4.3.3, Sampling Methods, Page 7: The middle of this paragraph indicates that purge water may be extracted from monitoring wells with a large water column using a variety of pumps, including a peristaltic pump. Peristaltic pumps are typically used for low-flow sampling, and generally do not operate at pumping rates that are suitable for purging wells with a large water column. Please revise the FSP to clarify how a peristaltic pump will efficiently extract purge water from wells with a large water column, or alternatively, please remove peristaltic pump from the list of wells that will be used for this purpose.**

Response: The reference to a peristaltic pump has been deleted from Section 4.3.3.

7. **Comment:** **Section 4.4, Well Installation, Pages 8 and 9: The text in this section indicates that B-aquifer monitoring wells will be drilled to a depth of approximately 75 feet below ground surface (bgs), and that wells will be drilled using either air rotary or mud rotary drilling methods. Additionally, this section indicates that pilot borings may be drilled prior to well installation, in order to optimize well screen placement. According to page A-12 of the QAPjP (Section A1.4.4, Step 4-Define the Study Boundaries), "The vertical limit of the B-aquifer study area is a depth of 5 feet below the bottom of the B-aquifer or to the bottom of VOC contamination, whichever is less." It appears that in order to satisfy this DQO, hydropunch samples should be collected from the pilot borings and analyzed for VOCs prior to installation of the B-aquifer monitoring wells, in order to ensure that the B-aquifer monitoring wells are screened to the bottom of the VOC contamination. Alternatively, the FSP should state that the pilot borings will be used to identify the bottom of the B-aquifer, and all of the B-aquifer monitoring wells will be screened to the bottom of the B-aquifer. Please revise the FSP to clarify how the proposed well installation methodology for the B-aquifer wells will be applied to ensure that the DQO regarding the spatial limits of the B-aquifer study will be achieved.**

Response: The FSP will be revised to indicate that the new B-aquifer monitoring wells will be screened to the bottom of the B-aquifer. However, note that the use of pilot borings and the geologic logging procedures for the well installation activities were revised based on comments received from the Department of Toxic Substances Control (DTSC). Please refer to the Navy's response to DTSC's comment 5 on the FSP regarding revisions to the well installation procedures to be used for the PGDGI.

8. **Comment:** **Table 4-2, Results of Well Condition Survey: This table lists wells IR07MWS-2 and IR18MW21A as needing top of casing survey measurements under the category "WELLS FOR WHICH ADDITIONAL SURVEY DATA ARE NEEDED" (Page 1 of 5), and they are also listed as abandoned under the category "WELLS THAT ARE NOT AVAILABLE FOR SAMPLING" (Page 3 of 5). Please revise Table 4-2 to explain or correct this apparent discrepancy.**

Response: The wells identified above were abandoned during the Parcel B remedial action and subsequently re-installed. In addition, survey data for the newly installed wells have been incorporated into the project database. Table 4-2 will be revised to delete reference to the wells.

9. **Comment:** **Tables 4-5 and 4-6: Tables 4-5 and 4-6 present the rationale for resampling groundwater from monitoring wells in Parcels C and D. The following objectives are repeated for several wells in the list of rationale:**

- **Conclusions from 2/7/00 and 3/16/00 BCT working meetings.**
- **Obtain TDS data for beneficial use analysis.**
- **Evaluate geology and hydrogeology of B-aquifer.**

However, the FSP does not explain these rationale, the conclusions from the working meetings are not discussed and an elaboration regarding how the geology and hydrogeology of the B-aquifer will be evaluated is not provided. Please revise the FSP to provide a more complete explanation of the general rationale listed above for resampling monitoring wells.

Response: Please refer to the Navy's response to specific comment 4 on the FSP regarding conclusions from previous BCT meetings, response to general comment 2 regarding beneficial use analysis, and response to specific comment 2 on the FSP regarding evaluation of geology and hydrogeology.

SPECIFIC COMMENTS – QUALITY ASSURANCE PROJECT PLAN

1. **Comment:** **A1.3.3, Phase I Groundwater Data Gaps Investigation, Page A-4, last sentence. After "since" please add "the Navy did not agree that."**

Response: The text will be revised accordingly.

2. **Comment:** **A1.3.3, Phase I Groundwater Data Gaps Investigation, Page A-5, second paragraph, first sentence. After "comments" please add "received on the beneficial use evaluations completed for Parcel D".**

Response: The text will be revised accordingly.

3. **Comment:** **Table A-2, Identification of the Seven Steps of the Data Quality Objectives Process, Task 1, Page A-6: The second bullet under Step 5 (Develop Decision Rules) for Task 1 (assess the condition of all existing wells) states that if a monitoring well has significant damage that is beyond repair, then the well will be abandoned, and if the well location is deemed necessary for future monitoring, then the well will be replaced. According to Table 4-2 of the FSP (Results of Well Condition Survey), the following wells will be abandoned, because of excessive silt inside the well: IR07MWS-2, IR01MWI-8 and PA36MW03A. Please clarify how the decision will be made whether or not to replace these wells, and how regulatory concurrence will be obtained.**

Response: Decision rules for abandoning and replacing wells are provided under Step 5 of the DQO table and on page A-13 of the text. Wells will be abandoned and replaced (if necessary) in accordance with the DQO decision rules. The BCT will be informed of all well abandonment and replacement (if necessary) activities. To clarify, Table 4-2 identifies well IR07MW20A2, not well IR07MWS-2, as more than 50 percent silted. However, since all three wells in which silt obscures more than 50 percent of the screened interval are located in either Parcel B or Parcel E, no determination about abandonment and replacement of those wells will be made during the PGDGI.

4. **Comment:** **Table A-2, Identification of the Seven Steps of the Data Quality Objectives Process, Task 3, Page A-7: The first paragraph under Step 1 (State the Problem) for Task 3 (perform additional characterization of the B-aquifer in Parcels C and D) states that "The extent of contamination in the B-aquifer and its relationship to the A-aquifer at Parcels C and D (and, potentially, at a part of Parcel B) have not been evaluated..." Please clarify under what conditions would this task include an evaluation of the B-aquifer at Parcel B. This task is called characterization of the B-aquifer in Parcels C and D, and yet the sampling effort appears to include monitoring wells in Parcels B, C, D and E. Additionally, it is not clear if there are any new wells proposed for Parcel B. The last paragraph of Step 3 for this task indicates that new wells will be installed in Parcel B, but these wells are not listed anywhere in the QAPjP or the FSP. Please revise the QAPjP to indicate 1) under what conditions will existing Parcel B wells be included in the B-aquifer study, 2) if there are any new wells proposed for installation in Parcel B, or under what conditions might new wells be installed in Parcel B as part of this data gaps investigation, and 3) if there are new wells proposed for installation in Parcel B, the location of these new wells.**

Response: Two proposed B-aquifer wells and two proposed A-aquifer wells located within the boundary of Parcel B will be used to refine the IR-25 (Parcel C) volatile organic compound plume boundary. The locations of those wells are shown on Figure 4-4 of the FSP. Although the contamination potentially extends into Parcel B, the source area is located in Parcel C, and therefore, the sampling efforts are associated with the Parcel C investigation.

5. **Comment:** **Table A-2, Identification of the Seven Steps of the Data Quality Objectives Process, Task 3, Page A-7: The last paragraph under Step 1 for Task 3 states that "Furthermore, TDS and yield data are insufficient to evaluate if cleanup to drinking water standards is necessary." EPA does not necessarily agree with this statement (see General Overall Comment 1 above). Further, determination of the need to clean up an aquifer to drinking water standards is not solely dependant upon the beneficial use determination of an aquifer. For example, an aquifer classified as a drinking water aquifer may not require clean up to drinking water standards, because of other mitigating factors. Alternatively, an aquifer that is not classified as a drinking water aquifer according to the TDS and yield criteria may require clean up to drinking water standards, in order to protect an underlying drinking water aquifer. Please revise this DQO**

to indicate that there is insufficient TDS and yield data to classify the B-aquifer according to federal and state criteria.

Response: The text will be revised accordingly.

6. **Comment:** **Table A-2, Identification of the Seven Steps of the Data Quality Objectives Process, Task 3, Page A-7: The third bullet under Step 5 (Decision Rules) for Task 3 states that TDS and yield data from the B-aquifer will be compared to state and federal exemption criteria for drinking water sources. However, there is no discussion of the collection of yield data presented in the FSP, and therefore it is not clear what data will be compared to the state and federal criteria. Will yield data collected during the RI be used? Is the Navy going to assume that all wells are likely to meet the yield criteria? Please clarify.**

Response: Please refer to the Navy's response to specific comment 2 on the FSP.

HUNTERS POINT SHIPYARD
DRAFT FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN
FOR PHASE I GROUNDWATER DATA GAPS INVESTIGATION
RESPONSE TO COMMENTS FROM
U.S. ENVIRONMENTAL PROTECTION AGENCY QUALITY ASSURANCE OFFICE

This document presents the Navy's responses to comments from the U.S. Environmental Protection Agency (EPA) on the Draft Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) for the Phase I Groundwater Data Gaps Investigation (PGDGI), Hunters Point Shipyard (HPS), San Francisco, California, dated June 1, 2000. The comments addressed below were received from the EPA Quality Assurance (QA) office on June 19, 2000.

RESPONSES TO EPA

Concerns

1. **Comment:** **[General] The QAPP and FSP provide limited background information. The introduction to the QAPP states that a site background with results of previous investigations is presented in this QAPP, and references other documents. However, neither the QAPP or FSP provide the analytical results from past investigations. It is recommended that the significant analytical results of past studies be summarized in the documents.**

   Response: The Navy will include summary tables for groundwater results that exceeded maximum contaminant levels (or ambient levels) as an appendix to the FSP; however, the Navy wishes to clarify that complete analytical results are presented in the remedial investigation (RI) reports for the individual parcels at HPS and are appropriately referenced in the FSP and QAPP for the PGDGI.

2. **Comment:** **[QAPP: Section A1.4, Data Quality Objectives; Table A-2, Identification of the Seven Steps of the Data Quality Objectives Process] Section A1.4.6 and Table A-2 of the QAPP state that judgmental sampling is being utilized, therefore, a statistical model is not appropriate. However, the plan should discuss how the chosen number of samples was deemed sufficient for project specific objectives.**

   Note, for consistency the information provided in Section A1.4.3 (page A-11) regarding 54 A-aquifer and 14 bedrock water-bearing zone wells should be added to Step 3 of Table A-2 (page A-8).

   Response: The analysis of the sampling design for the PGDGI is discussed in Section A1.4.7 of the QAPP (pages A-17 and A-18). In addition, the sampling design was developed with input from the Base Realignment and Closure (BRAC) Cleanup Team (BCT) during a series of working meetings conducted in February and March 2000.

   Section A1.4.3 and Table A-2 will be revised to reflect the correct number of wells to be sampled.

3. Comment:

A. [QAPP: Section A2, Project and Task Organization; Figure A-2, Organization Flowchart] Section A2.1 identifies Mr. Richard Mach as Base Realignment and Closure (BRAC) Environmental Coordinator and Ms. Susan Gallagher as Sample Tracking Coordinator. However, these personnel are not depicted on the organization chart. These should be included in the chart.

B. Figure A-2 indicates that Project On-Site QA Officer and Health and Safety Officer are yet to be determined. The final QAPP should identify these personnel.

C. Section A2.2 (page A-21) states that the Installation Coordinator is responsible for coordinating with subcontractors. Section A2.2 (page A-27) also indicates that TtEMI Project Chemist will be responsible for setting up the contractor laboratories. However, the subcontractors are not identified. It is recommended that the QAPP identify the subcontractors and depict them on the organization chart.

Note, Section A2.2 should read Figure A-2, and not A-4.

Response: Figure A-2 will be revised to include Mr. Mach, Ms. Gallagher, three analytical laboratories (Severn Trent, APCL, and Curtis & Tompkins), the data validation company (ETHIX), the on-site health and safety officer (Deborah Cheng), and the on-site quality assurance officer (Doug Sterling).

4. Comment:

[QAPP: Section A4.2, Project Measurements; Appendix 2 – Table 2-2, Comparison of Detection Limits and Analyte Screening Criteria] Section A4.2 of the QAPP states that low-level analytical methods will be used for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs) analyses as those methods meet the screening criteria identified in Table 2-2 of the QAPP. However, Table 2-2 indicates that the laboratory reporting limit (LRL) for 1,1,2,2-Tetrachloroethane is higher, 2 microgram/liter (mg/L), than the corresponding maximum contaminant level (MCL) of 1 mg/L. Similarly, the LRL for thallium is higher (2.7 mg/L) than the corresponding MCL of 2 mg/L. In fact, Table 2-2 indicates that the LRL for these analytes meets criterion. This issue should be addressed.

Note, Table 2-2 indicates that the LRL for many analytes are equal to the corresponding MCLs. It is suggested, if possible, the reporting limits should be lower than the MCL to ensure confidence in the data at the decision making level (MCL).

Response: Table 2-2 will be revised to reference the LRL for 1,1,2,2-tetrachloroethane as 1.0 μg/L. However, Table 2-2 will not be revised for thallium because the LRL for thallium is well below the appropriate criterion. In particular, the appropriate criterion for metals in groundwater is either the MCL or the Hunters Point groundwater ambient level (HGAL), whichever is higher; therefore the LRL for thallium (2.7 μg/L) is well below the appropriate criterion (HGAL = 13.0 μg/L).

The decision rules are based on exceedances of MCLs; therefore, the Navy believes it is appropriate that some of the LRLs be equal to the corresponding MCLs. Since the method detection limit (MDL) for each analyte is at or below the reporting limit, detected or nondetected results reported at the reporting limit should be reliable. Further, the laboratory reports results down to one-half the reporting limit, if the analyte is detected in the sample.

5. **Comment:** **[QAPP: Sections A5.5.1, Precision; Appendix 3 – Precision and Accuracy Goals] Section A5.5.1 of the QAPP states that the control limits for precision of field duplicates and laboratory matrix spikes are set at 25 relative percent difference (RPD) for water samples. However, Appendix A-3 of the QAPP provides different RPD criteria specific to each analyte. This inconsistency between text and tables should be resolved.**

Response: Section A5.5.1 will be revised to specify a quality control limit of 25 percent relative percent difference for field duplicate, and will refer to Appendix 3 for quality control limits for matrix spike and matrix spike duplicate samples.

6. **Comment:** **[QAPP: Section A6.3, Data Package Format – Data Storage and Disposal] Section A6.3 of the QAPP states that the raw data will be retained by the laboratory on magnetic tapes. Region 9 requires that gas chromatography/mass spectrometry (GC/MS) data on magnetic tapes should be provided to the Navy along with other laboratory data deliverables. In turn, the magnetic tapes can be made available to Region 9 upon request. The Navy has previously commented that they do not have space to archive data tapes. Region 9 is willing to archive the tapes.**

Response: The Navy is amenable to working with EPA to provide the required gas chromatography/mass spectrometry (GC/MS) magnetic tapes. In the past, GC/MS magnetic tapes have been archived at the analytical laboratory; all tapes at the laboratory are available for audit.

7. **Comment:**

A. [QAPP: Section C1, Assessments and Response Actions] Section C1 indicates that three types of audits may be conducted, but does not specify what audits are planned for the project. This information should be provided.

B. Section C1.1.1 states that TtEMI conducts laboratory audits as a condition of contract award. It is recommended that copies of all audit reports be submitted to Region 9.

C. Section C1 of the QAPP does not include a provision for analyzing double blind performance evaluation (PE) samples. Region 9 requires that double blind PE samples be analyzed for laboratory evaluation. The QAPP should specify the frequency and acceptance criteria for PE samples. In addition, the results of PE samples should be made available to Region 9.

Response: A. Some audits are announced beforehand and some are not. Both TtEMI and the Navy QA Officer plan to conduct field audits; however, the type and frequency of subsequent audits are based on the results of the initial audits.

B. The audit reports will be made available to EPA Region 9.

C. As noted in Section A5.3, PE samples will be analyzed. Section C1 of the final QAPP will be revised to set forth in detail the frequency and acceptance criteria for the PE samples. Results of the PE samples will be made available to EPA Region 9.

8. Comment: **[QAPP: Appendix 1 – Chain of Custody Record] The chain of custody form should identify the environmental sample to be used for QC purposes to ensure that the laboratory will not mistakenly spike a blank.**

Response: The Navy acknowledges EPA's comment and will ensure that the field sampling crews make the appropriate notation to indicate whether or not a sample is intended for quality control in the sample description/notes field of the chain-of -custody form.

9. Comment: **[FSP: Section 4.4, Well Installation] Section 4.4 of the FSP provides general well specifications for the project. In addition Region 9 requires that a table identifying the well specifications (well depths, casing diameters, screen intervals) for all new wells be included in the FSP.**

Response: Section 4.4 will be revised to include information about selected casing diameters and the rationale for determining the well depth and screen interval; however, determination of the actual well depth and screen intervals will be based on site-specific lithology encountered in the field.

10. Comment: **A. [FSP: Table 4-4, Data Collection Requirements] Table 4-4 of the FSP provides limited information for the proposed quality control (QC) for the project. The field duplicate locations are not identified in the table or in the associated text. It is recommended that the table identify the locations where the duplicate samples will be collected.**

B. Table 4-4 indicates that two equipment rinsates per week per field crew will be collected. Region 9 requires at least one equipment rinsate blank per day per parameter be collected.

In addition, Table 4-4 does not indicate that a double volume of ground water should be collected for laboratory QC purposes.

Response: A. The Navy acknowledges EPA's comment; however, it is not practical to determine in advance the locations at which field duplicate samples will be collected. The ability of an individual well to produce sufficient water for field duplicates is unknown (since most of the wells have not been sampled for several years). The Navy will adhere to the sampling frequency listed in Table 4-4.

B. Table 4-4 will be revised to include collection of at least one equipment rinsate blank per day per parameter.

Table 4-4 will be revised to indicate that a double volume of water will be collected for matrix spike/matrix spike duplicate samples.

[FSP: Figures 4-1 through 4-4, Site Maps] The directions of surface and groundwater flow have not been depicted on any of the site maps provided. It is recommended this be depicted in the figures.

Response: Approximate groundwater flow directions are available for the site; however, the information used to determine groundwater flow direction may be outdated, and the groundwater flow direction may be subject to the influence of utility lines. Since one objective of the investigation is to determine horizontal groundwater flow directions, the Navy believes it is premature and potentially misleading to depict groundwater flow directions on the basis of information that is to be revised.

Additional Comments

1. Comment: **[General] Both the QAPP and FSP are dated June 1, 2000, yet all approval signatures are dated in late May.**

Response: Advance signature of the FSP and QAPP was required to meet the Navy's contractual requirements and to meet the project schedule for review by the BCT.

2. Comment: **[QAPP: Section A3, Site Background and Problem Definition] Section A3 (page A-32) should read Table 4-4 of the FSP, and not 4-1.**

Response: Section A3 will be revised accordingly.

3. Comment: **[QAPP: Section B5, Analytical Methods] Section B5 of the QAPP (page B-8) states that *in-situ* measurements of ground parameters is detailed in Section 4.3.6 of the FSP. Section 4.3.6 of the FSP could not be located.**

Response: Section B5 will be revised to refer to Section 4.3.3 of the FSP.

4. Comment: **[QAPP: Section B6.1.4, Equipment Rinsate Blanks] Section B6.1.4 states that the frequency of collection of equipment rinsate blank samples is presented in Table B-1. However, this table could not be located.**

Response: Table B-1 is located on Page B-9 of the QAPP; however, Section B6.1.4 will be revised to also refer to Table 4-4 of the FSP.

5. Comment: **[FSP: Section 7.0, Health and Safety] Section 7.0 cites a basewide health and safety plan (HSP); however, the HSP is not included with or attached to the FSP. The HSP must accompany the FSP in the field.**

Response: The field crew is provided with the HSP, along with the FSP and the QAPP.

HUNTERS POINT SHIPYARD
DRAFT FIELD SAMPLING PLAN
FOR PHASE I GROUNDWATER DATA GAPS INVESTIGATION
RESPONSE TO COMMENTS FROM
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

This document presents the Navy's responses to comments from the California Regional Water Quality Control Board (RWQCB) on the Draft Field Sampling Plan (FSP) for the Phase I Groundwater Data Gaps Investigation (PGDGI), Hunters Point Shipyard (HPS), San Francisco, California, dated June 1, 2000. The comments addressed below were received from the EPA Quality Assurance office on June 16, 2000.

RESPONSES TO RWQCB

General Comments

1. **Comment:** **We understand that groundwater data gaps may also exist on Parcel E. Please mention that the purpose and objective of this particular phase of work is focused on Parcels C and D. Additional work may be required for Parcels C and D, depending on the outcome of Phase I, and for Parcel E, pending additional evaluation of groundwater conditions there.**

   Response: Section 2.0 of the FSP will be revised to reflect RWQCB's comment.

2. **Comment:** **Section 4.3.4 – Sample Analysis: To prevent the problems associated with "fizzing" of hard groundwater when HCl or H_2SO_4 are used as preservatives in volatile organic chemical (VOC) samples, we encourage the Navy to investigate the use of solid $NaHSO_4$ as a preservative. Alternatively, if unpreserved VOC samples are collected, it is our understanding that allowable holding times must be reduced.**

   Response: The Navy will evaluate the potential of using solid $NaHSO_4$ as a preservative. If "fizzing" problems associated with hard groundwater are encountered in the field, the Navy will use solid $NaHSO_4$ as a preservative or will collect an unpreserved sample to be extracted at the laboratory within the allowable holding time.

3. **Comment:** **Section 4.4 – Well Installation: Please describe how well screen lengths and depths will be determined. For A-aquifer wells, we request that the screen extend at least one foot above the highest seasonal groundwater elevation.**

   Response: The FSP will be revised to indicate that well screen lengths will typically be 10 feet, but that the lengths may be modified to accommodate site-specific conditions. RWQCB's request for well screen placement for the A-aquifer is noted, and such placement will be specified in the FSP.

4. **Comment:** **Although Table 4-4 shows that oxidation-reduction potential (ORP) will be measured in numerous wells, we could not identify a location where this is described in the text or in Tables 4-5 and 4-6. Please state explicitly in the text where, why, and how these data will be collected. As was discussed in our letter dated June 8, 2000, Regional Board staff find measurements of dissolved oxygen concentration (DO) and ORP to be very useful in evaluating groundwater contamination and natural attenuation and believe that measurements are more accurate when done in-line with the monitoring well purging parameters. Please investigate the potential for collecting DO and ORP data along with the other well purging parameters.**

Response: Section 4.3.3 of the FSP currently specifies the collection of dissolved oxygen measurements during well purging, and the section will be revised to also specify that ORP measurements will be collected during well purging.

5. **Comment:** **Please state explicitly if extractable petroleum analysis will or will not incorporate silica gel cleanup.**

Response: As stated in Appendix 2 (Table 2-2) of the accompanying quality assurance project plan, extractable petroleum analyses will incorporate silica gel cleanup.

6. **Comment:** **Table 4-4 states several times that Aroclor-1260 is the only PCB analyte of concern, while this may be the case, please provide assurance that all analytes in the PCB/pesticides method will be reported by the laboratory and all detections will be noted in the resulting document.**

Response: The Navy confirms that polychlorinated biphenyl (PCB) or pesticides analytes detected by the laboratory will be reported; however, the Navy wishes to clarify that samples may be analyzed only for PCBs at wells for which there are no pesticides analytes of concern.

7. **Comment:** **Please provide a narrative description of the beneficial use analysis referenced in Tables 4-5 and 4-6. Since this appears to be a significant objective of the FSP, it seems appropriate to explicitly identify and describe the metrics for this objective.**

Response: Section 2.0 of the final FSP will be revised to elaborate on the beneficial use analysis referred to in Table 4-5.

8. **Comment:** **We have received USEPA's comments on the FSP and concur with their assessments on wells to be monitored and analyses to be performed.**

Response: RWQCB is referred to the Navy's draft responses to comments from U.S. Environmental Agency Region 9.

HUNTERS POINT SHIPYARD
DRAFT FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN
FOR PHASE I GROUNDWATER DATA GAPS INVESTIGATION
RESPONSE TO COMMENTS FROM
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

This document presents the Navy's responses to comments from the California Department of Toxic Substances Control (DTSC) on the Draft Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) for the Phase I Groundwater Data Gaps Investigation (PGDGI), Hunters Point Shipyard (HPS), San Francisco, California, dated June 1, 2000. The comments addressed below were received from DTSC on June 23, 2000.

RESPONSES TO DTSC

Comments on QAPP

1. **Comment:** **Data Quality Objectives (DQOs). The DQOs (Table A-2) in the QAPP are not fully responsive to DTSC's comments on the draft DQOs (letter from Chein Kao to Richard Mach dated May 04, 2000). For example, determination of the extent of dense non-aqueous phase liquids (DNAPLs) and determination of potential pathways of DNAPLs should be included in the problem statements of this data gap investigation. DNAPL concerns have been identified as data gaps on numerous occasions, both in comments and in meetings. When does the Navy intend to address DNAPL issue? Similarly, the extent of light non-aqueous phase liquids (LNAPLs) has not been determined. Another example--optimizing sampling design (Step 7) by eliminating wells that need development or replacement is not an approach acceptable to DTSC. DQOs should also be summarized in the FSP--for example, in a summary table.**

   Response: The Navy acknowledges DTSC's comment and wishes to clarify several issues as follows. First, the Phase I sampling plan is intended to be used to refine the plume boundaries and to evaluate the potential for contaminant migration and/or attenuation. The plume refinement and evaluation activities will provide additional data on volatile organic compound (VOC) concentrations and will aid in a preliminary evaluation of dense non-aqueous phase liquids (DNAPL) at HPS. Additional data regarding potential DNAPLs at HPS will be evaluated as part of the proposed treatability study activities at Parcels C and E. In addition, the Phase II activities may include additional investigation for DNAPLs, if deemed appropriate by the Base Realignment and Closure (BRAC) Cleanup Team (BCT).

   Second, light non-aqueous phase liquids (LNAPL) will be evaluated under the petroleum hydrocarbon program unless the contaminants are commingled with Comprehensive Environmental Response, Compensation, and Liability (CERCLA) constituents, in which case additional LNAPL characterization data will be collected concurrent with the DNAPL characterization efforts.

Third, wells will not be eliminated from the sampling program based on the need for repair, redevelopment, or replacement. Rather, wells that are needed for the sampling program will be repaired, redeveloped, or replaced as necessary. Section A1.4.7 and Table A-2 of the QAPP will be revised accordingly.

Finally, since the QAPP supplements the FSP, as is stated in Section 1.0 of the FSP, the Navy believes that it is duplicative to summarize the data quality objectives in both documents. Field crews are expected to have both the FSP and the QAPP on hand at all times, and the final version of the FSP and QAPP will be placed together in the same binder.

2. Comment: **Site Histories. Page A-32. The text says: "Parcel C areas that have significant contamination are located in IR25 and IR28." The text is misleading when it confines the discussion to Installation Restoration sites (IRs) IR25 and IR 28. Moreover, it doesn't adequately capture the discussions of the scoping meetings. Remedial units (RUs) were defined in previous reports, comments, and meetings, based on ecological and human health inhalation pathways only. RU boundaries required reevaluation when the drinking water pathway was added during the risk management review sessions. Some of the RUs are not associated with IRs 25 and 28. In addition, upon consideration of drinking water pathways, other areas with exceedences were discussed at the scoping meetings. Previous RUs have been combined into new RU-Cs and RU-D1, after the addition of the drinking water pathway. To clarify the relationship between previous RUs and current RU-Cs, a figure should be included (in an appendix) which shows the extent of the former Rus. The site history section should be expanded and results of previous groundwater sampling events should be included, along with potentiometric surface maps.**

Response: The Navy wishes to clarify that the "Parcel C areas that have significant contamination," as referenced in DTSC's comment, are based on RUs as identified in the draft final Parcel C feasibility study (FS) that are physically located in IR sites IR-25 and IR-28. The Navy acknowledges that these RUs were expanded, based on point exceedances of maximum contaminant levels (MCL) or Hunters Point groundwater ambient levels (HGAL), during a series of working meetings with the BCT in February and March 2000. Although these expanded boundaries may extend slightly into other IR sites, the Navy believes that a further description of the site history at other IR sites would be duplicative and unnecessary. In addition, the minutes from the working meetings with the BCT will be included as Appendix D to the FSP; DTSC is referred to these meeting minutes as a means to verify that the FSP and QAPP adequately capture the conclusions of the meetings. A new figure depicting the original and revised RUs will be included in the final FSP. In addition, the Navy will include summary tables for groundwater results that exceeded MCLs or HGALs as an appendix to the FSP. Potentiometric surface maps will not be included in the FSP since the information may be outdated, and the groundwater flow direction may be subject to the influence of utility lines. Since one objective of the investigation is to determine horizontal groundwater flow directions, the Navy believes it is premature and potentially misleading to depict groundwater flow directions on the basis of information that is to be revised.

3. **Comment:** **The QAPP should cite the FSP explicitly in the <u>Introduction</u> and in <u>References</u>. Also, it seems the FSP (the document) is also referred to as PGDGI (phase I groundwater data gap investigation). One acronym should suffice. The Health and Safety Plan (HSP) referenced has not been received at DTSC. The HSP should be included in the <u>Introduction</u> and in <u>References</u>.**

Response: Section 1.0 of the QAPP refers to the FSP as an accompanying document that forms the sampling and analysis plan. Additional text will be added to Section 1.0 of the QAPP to further explain the link between the QAPP and the FSP. The acronym "PGDGI" refers to the Phase I groundwater data gaps investigation and not to any specific document. Reference to the project health and safety plan (HSP) is adequately addressed in Section 7.0 (Health and Safety) and Section 9.0 (References) of the FSP. In addition, the field crew is provided with the HSP, along with the FSP and the QAPP.

4. **Comment:** **<u>QAPP Applicability</u>. The QAPP says that it is intended to be applicable to Parcels B, C, D, and E. However, DQOs and site histories are included for Parcels C and D only, and there are multiple references to the PGDGI (which refers to the phase I groundwater data gap investigation for Parcels C and D only) and to the FSP (which also applies to the PGDGI). As it stands now, the document is only applicable to Parcels C and D. It will require significant revision for applicability to other parcels.**

Response: Clarifying text will be added to Section A1 of the QAPP to indicate that the focus of the PGDGI is on Parcels C and D; however, additional wells in Parcels B and E have been included in the investigation for water level measurement to assess basewide groundwater flow patterns. In addition, installation of several wells at Parcel B is proposed to aid in the delineation of groundwater contamination in the vicinity of IR-25 (Parcel C). The QAPP has been prepared specifically to support the PGDGI and will be revised, as necessary, to support the Phase II and Phase III groundwater data gaps investigations.

5. **Comment:** **<u>Quality Assurance (QA) Review</u>. A detailed review of QA procedures is being performed by USEPA's QA team. Laboratory QA requirements in the QAPP are reportedly consistent with USEPA's contract laboratory program (CLP) requirements. Consistent with previous QA documents for this site, DTSC defers to USEPA in this regard (e.g., Sections A5.6, A6, B and D). USEPA's comments are contained in the letter of June 19, 2000 from Claire Trombadore to Richard Mach. For the sake of brevity, they will not be repeated here. Percent recovery and relative percent differences (RPD) (Tables 3-1 to 3-5) are not all consistent with recommendations of the State of California Hazardous Materials Laboratory's Users Manual (revised 1999).**

Response: DTSC is referred to the Navy's draft responses to comments from U.S. Environmental Agency Region 9 (EPA) QA office. To clarify DTSC's additional comments, the percent recovery limits listed in Appendix 3 of the QAPP are consistent with Contract Laboratory Program (CLP) limits that have been used previously on the HPS project and are consistent with EPA's Superfund Program. In addition, Appendix 3 will be revised to specify a quality control limit of 25 percent relative percent difference for all analytes.

6. **Comment:** **<u>Monitoring Well Sampling Sheet</u>. Monitored natural attenuation (MNA) field parameters should be added to this sheet (e.g., ferrous iron). Low flow with minimal drawdown (i.e., micropurging) techniques are recommended for MNA parameters (and other compounds), in order to minimize introduction of air into the well. This sheet is designed around the concept of extracting three well volumes for purging, not around the concept of micropurging. As such, some critical parameters are not included. Purge rate should be recorded and/or calculated (e.g., time since beginning of purging needs to be added). Sampling rate should never exceed purge rate. During purging, pumping at a rate (less than 1 liter per minute) that does not lower the level of water in the well more than 10% of the screened length is one rule of thumb that has been applied (i.e., at Dover Air Force Base). Wells can be pumped in excess of 1 liter per minute so long as drawdown does not exceed 10% of the screened length. During sampling, pumping rate should be reduced to 100 milliliters per minute. The samples should be collected in order of susceptibility to artificial aeration (e.g., volatile organic compounds (volatile organic compounds (VOCs), total organic carbon (TOC), methane, iron, sulphide, alkalinity, sulphate). Sampling tube should be held against/very close to the mouth of the sample container (held at an angle) to prevent aeration. In-line filtration is required. Dissolved oxygen (DO) reading greater than 10 mg/l should be resampled. DO is sensitive to temperature (T) so T readings should accompany DO readings, and care should be taken to eliminate T gradients (i.e., those cause by sunlight, hot surfaces, etc.). The relationship between DO and Eh should be plotted in the field to catch any errors and allow for immediate resampling. It is confusing that this Monitoring Well Sample Sheet is included in the QAPP and another sheet, specific to micropurging, is included as an attachment to standard operating procedure (SOP) 015 (Attachment A of the FSP). Which sheet is to be used? (See also FSP comment 8.)**

Response: The Navy acknowledges DTSC's recommendation for use of low-flow purging techniques for collection of MNA parameters, and Section 4.3.3 will be clarified to state that micropurging techniques, consistent with those outlined in Tetra Tech EM Inc. (TtEMI) standard operating procedure (SOP) No. 15, will be the preferred sampling method for the PGDGI; however, standard well purging and sampling techniques, consistent with TtEMI SOP No. 10, may be used as field conditions warrant. In particular, the time required to achieve parameter stabilization, due to the fact that most wells have not been sampled in more than four years, may make micropurging techniques impractical. The sampling form in the QAPP has been replaced with the form included in the FSP. Field test kit parameters will be recorded in the "remarks" column and in the field book. Sampling and purge rate protocol for micropurging are included in the FSP

(Appendix A, SOP No. 15) and the order of sample collection is explained on Page 8 of the FSP. Sample collection techniques are described in TtEMI SOP No. 10. In-line filtration will be used as is stated on page 8 of the FSP. The micropurging sampling form (from TtEMI SOP No. 15) includes columns for temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP); these parameters will be measured and interpreted as described in the FSP and the applicable SOP, but the Navy does not believe it is either necessary or practical to plot these parameters in the field.

7. Comment: **Chain of Custody (COC) Record. Temperature should be added to the COC record.**

Response: As stated on page 8 of the FSP, samples will be immediately transferred to a cooler maintained at 4 degrees Celsius (C). Upon sample receipt at the laboratory, personnel will record the temperature on the COC or a receipt per Section B4.1.5 of the QAPP. Because cooler temperature will be recorded at the time of receipt and because samples will be maintained at 4 degrees C until sent to the laboratory, the Navy does not feel it is necessary to include temperature on the COC at the time of shipment; however, it is standard laboratory protocol to record the temperature of incoming samples.

8. Comment: **Table 2-1. For mercury (Hg), holding times are 28 days for glass but 13 days for plastic. Since plastic is proposed as the container, the holding time should be changed to 13 days. For pesticides (but not for polychlorinated biphenyls (PCBs)), a pH of 5 to 9 is recommended for preservation. Under nitrate and total dissolved solids (TDS), what does "MCAWW" mean? Regarding ferrous iron field analysis, please provide information (catalogue or brochure) on HACH Method 8149, Color disc/PAN.**

Response: The mercury and PCB information provided in Table 2-1 are consistent with CLP practices that have been previously used on the HPS project and are considered appropriate. The acronym MCAWW stands for Method for Chemical Analysis of Water and Wastes, and will be appropriately referenced in Table 2-1. Information on the Hach field test kit to be used for the PGDGI will be forwarded to DTSC.

9. Comment: **Table 2-2. For TDS, no water quality criteria are listed. However, they do exist are an essential component of this investigation. Both the USEPA's and the RWQCB's criteria for drinking water aquifers should be listed. Also, the laboratory reporting limit (LRL) is equal to the USEPA's criterion (10,000 mg/L) and it is greater than the RWQCB's criterion (3,000 mg/L). This will be problematic in data interpretation, since areas that exceed the RWQCB's criteria but do not exceed the USEPA's criteria will not be able to be delineated. The table should include both state and federal maximum contaminant levels (MCLs). Other LRLs are greater than criteria cited (i.e., 1,1,2,2-tetrachlorethane and thallium).**

Response: The EPA and Regional Water Quality Control Board (RWQCB) criteria have been included in Table 2-2. The LRL for TDS are correctly reported in Table 2-2 as 10,000 micrograms per liter (μg/L), or 10 milligrams per liter (mg/L); this LRL is well below the EPA and RWQCB criteria. Table 2-2 will be revised to reference the LRL for 1,1,2,2-tetrachloroethane as 1.0 μg/L. However, Table 2-2 will not be revised for thallium because the LRL for thallium is well below the appropriate criterion. In particular, the appropriate criterion for metals in groundwater is either the MCL or the HGAL, whichever is higher; the LRL for thallium (2.7 μg/L) is well below the appropriate criterion (HGAL = 13.0 μg/L).

10. **Comment:** **Subcontractors. Analytical laboratories and other subcontractors should be identified.**

Response: Figure A-2 in the QAPP will be revised to include three analytical laboratories (Severn Trent, APCL, and Curtis & Tompkins), and the data validation company (ETHIX). Procurement of other project subcontractors is ongoing and it is neither feasible nor appropriate to specify those parties at this time.

Comments on FSP

1. **Comment:** **DNAPLs and LNAPLs. The proposed phase I groundwater data gap investigation for Parcels C and D is generally responsive to DTSC's comments made during scoping meetings. However, a significant omission concerns determination of the extents and migration patterns of DNAPLs and LNAPLs. This data gap concerning NAPLs (especially DNAPLs) has been discussed in numerous comments and meetings. How does the Navy intend to address DNAPL concerns? This review assumes that LNAPLs will be further investigated as part of the RWQCB's corrective action program (CAP).**

Response: Please refer to the Navy's response to comment 1 on the QAPP regarding LNAPLs and DNAPLs.

2. **Comment:** **Other Agency Reviews. DTSC concurs with RWQCB's comments on the FSP and the QAPP (letter: June 16, 2000). Similarly, DTSC concurs with USEPA's comments on the FSP for Parcel C, (letters: June 13 and June 19, 2000). For the sake of brevity, those comments will not be repeated here (unless emphasis is intended, or a difference is noted in the comments below).**

Response: The comment is noted, and DTSC is referred to the Navy's draft responses to comments from EPA and the RWQCB.

3. **Comment:** **Purposes and Objectives. The purposes and objectives of the investigation, as well as a summary of the DQOs, should be included in the FSP. (QAPP comment 2 regarding site histories applies here as well.)**

Response: Please refer to the Navy's response to comment 1 (4th paragraph) on the QAPP regarding use of FSP information.

4. **Comment:** **Data Gaps. Data gaps should be explicitly identified, and the FSP should discuss how the proposed FSP will fill the data gap.**

Response: Section 2.0 of the FSP will be revised to include a discussion of the need for the data gaps investigation. A similar discussion was included in Section A1.4.1 of the QAPP.

5. **Comment:** **<u>New Wells</u>. A table should be included which lists all proposed new wells. Well specifications (e.g., depths, screened intervals, installation method, etc.) and rationales for well designs and for well locations should be included on the table. The FSP states that mud rotary or air rotary casing hammer (ARCH) drilling will be used. When will the drilling method be selected? What are the criteria for selection of drilling method? The FSP states (Section 4.4) that borings "may" be drilled prior to well installation. When will it be determined if the borings will be performed, and what are the criteria for making the determinations? Why are mud rotary borings to be used in lieu of a push type investigation? The FSP states that borings will be "abandoned". All borings should be grouted using a tremie pipe as per permit requirements. Use of the word "abandoned" is strongly discouraged (see FSP comment 6). What geophysical data will be collected? Soil sampling (chemical analytes and physical parameters) during well installation has not been included. Provide an explanation for not collecting soil samples. The FSP states that lithologic descriptions will be made from soil cuttings (from mud rotary drilling?). Will soil cores also be collected for evaluation by the field geologist? A figure should be included with proposed well construction details, to supplement to the table requested above. Will centralizers be used? Will groundwater samples be collected immediately after well development? Metals analyses can be high biased when samples are collected immediately after well development.**

Response: A table listing the proposed new wells and their specifications will be added to the FSP; however, the well specifications may be modified to accommodate site-specific conditions. Further, since the well specifications are subject to change, the Navy does not believe it is appropriate to prepare individual figures for each proposed well.

Air rotary casing hammer (ARCH) drilling methods will be the primary drilling method used in the well installation activities; however, the FSP states that either mud rotary or ARCH drilling methods may be used in order to provide the field team with flexibility to change drilling methods as field conditions warrant.

The FSP will be revised to state that all borings will be grouted using a tremie pipe. Upon review of DTSC's comments regarding soil sample collection, the Navy has reconsidered its approach and is proposing to collect soil core samples to confirm lithology; however, the collection of soil samples will not be required at locations where borings were installed during previous investigations. Further, the Navy does not believe that continuous coring is warranted given the number of existing borings at the site. The soil samples will be collected during the well installation activities in place of the drilling of pilot borings. Soil samples will be collected at 5-foot intervals within the A-aquifer and Bay Mud sediments, and at 10-foot intervals within the B-aquifer sediments. A single soil sample from each new B-aquifer well, at a depth within the well screen interval, will be retained and analyzed for effective porosity and hydraulic conductivity by American

Petroleum Institute (API) Method RP40 and American Society for Testing and Materials (ASTM) Method D5084, respectively.

Well centralizers will be used, as specified in Attachment 6.1 of IT Corporation's SOP No. 8.1. The new wells will be sampled a minimum of 24 hours after well development is complete, as stated in IT Corporation SOP No. 8.2. Additional sampling data to be collected in Phase II will aid in the determination of metals concentrations in the new wells.

6. **Comment:** **Monitoring Well Inspections. The first paragraphs of this section 4.1 are in contradiction with each other. The first paragraph says that the Navy has "completed" light maintenance but the third paragraph says that the Navy "will perform" basic maintenance. The current condition of each well cannot be ascertained from the information provided.**

Well Investigation Report. The Navy should prepare a report summarizing the well investigation, as requested in previous comments from DTSC. The scope of this report should be proposed by the Navy and discussed with agencies. The report should include: a table summarizing well specifications and well status, dates of installation/decommissioning, well inspection forms, decommissioning permits, photos, field logs, well logs, etc. Corrective action forms should be included. Of especial concern are the many wells noted as "abandoned" on Table 4-2. Does "abandoned" mean permitted decommissioning as per state and local laws and ordinances? Use of the term "abandoned" is strongly discouraged since its meaning is not clear in this context, and since it implies a dereliction of duty. Abandonment of wells is not allowed under California and local law and ordinances. It is noted that in previous comments (on the draft DQOs), approval by DTSC was required for well decommissioning. Was approval obtained for the wells listed as "abandoned?" If so, references for the approvals (i.e., letters, meetings) should be contained in the table. It is noted that for some wells with floating products, the extent of LNAPL has not been determined--this is a data gap, as previously noted. Some wells are "not located." What is the Navy's intention regarding locating these wells? Similarly, for some wells additional survey data are needed--what is the schedule for obtaining this data? As previously noted, the need for development of a well is not sufficient reason for eliminating the well from a sampling program or for decommissioning a well. Similarly, poor maintenance is not a sufficient reason fro exclusion from water level measurements or sampling programs. Many wells are noted as "missing top of casing." Has corrective action been taken for these wells? Have wells been re-surveyed? Are all wells locked? Please change page 4 (bottom) to read: "Wells should be repaired in accordance with California Water Well Standards and local ordinances."

Response: The statements in Section 4.1 regarding well maintenance are correct and not contradictory, as there is a stated difference between light and basic maintenance. The light maintenance tasks that have been completed to date and the basic maintenance tasks that will be completed are specified in Section 4.1.

In addition, information regarding the well inspections, including a summary of action taken to date and further recommended action, will be provided to DTSC following the completion of the PGDGI. In addition, wells needing additional survey data will be surveyed concurrent with the water level event scheduled for July 12, 2000. Further, the Navy wishes to clarify that no wells at HPS have been decommissioned based on the results of the well inspections. As stated in the Navy's response to comment 1 on the QAPP, wells will not be eliminated from the sampling program based on the need for repair, redevelopment, or replacement. Rather, wells that are needed for the sampling program will be repaired, redeveloped, or replaced as necessary.

7. Comment: **Well Level Measurements. A list of all wells for groundwater level measurements should be included. Proposed new wells (Figure 4-4 and 4-5) are not included in the figure indicating wells for water level measurements (Figure 4-1). Water levels should be taken in all wells at the time of sampling. This is standard procedure and a DTSC requirement. A schedule for water level measurement events should be included. Have all wells previously identified as having anomalous water levels been included?****

Response: A list of wells for groundwater level measurements was included in the FSP as Table 4-1; however, this table will be revised in response to comments provided by the BCT at the June 29, 2000 meeting. In particular, water level measurements will be collected at 189 A-aquifer wells and 19 B-aquifer wells basewide on July 12, 2000. In addition, a second B-aquifer water level measurement event will be conducted upon completion of the B-aquifer well installation activities (at locations depicted on Figures 4-4 and 4-5) and will include a total of 39 B-aquifer wells. Water level measurements will also be collected at the time of sampling as specified in the FSP. Further, the locations selected for the basewide water level measurement event have included numerous wells located near subsurface utility lines that may contribute to anomalous water levels in previous measurement events (as depicted on Figure 4-1).

8. Comment: **Sampling Methods (Section 4.3.3). The first few sentences of this section are in apparent contradiction--additional clarification should be provided. Will micropurging be used? If so, please note that a bailer cannot be used for micropurging, as noted in the USEPA guidance (Puls and Barcelona)--the primary reference for SOP 015 (Appendix A). This fact is also emphasized in SOP 015 (Section 2.0): "Bailers and high capacity submersible pumps are not considered acceptable micropurge sample collection devices." It is inappropriate to amend the SOP to allow the use of bailers, if that is indeed what is meant by section 4.3.3. In fact, the SOP makes no sense if bailers are to be used. SOP 015 is acceptable to DTSC, with the recommendations: 1) that sampling rate be included on the Micropurging Groundwater Sampling Data Sheet and 2) that future revisions incorporate requirements and guidelines for sampling for MNA parameters. Stabilization criteria that is used for this investigation should be the criteria cited in the SOP (not the criteria cited in this section). During purging, extracting four well volumes in lieu of parameter stabilization is acceptable, provided that the other requirements of the SOP are met (e.g., bailers have not been used). Moreover, to avoid aerating the water column, bailers cannot be used for collection of MNA parameters. (See also QAPP comment 6.) For which wells will the interface probe be used for both DNAPL and LNAPL testing? All wells where product has been detected previously or when free product**

is suspect should be tested (including those wells not in the sampling program). Free product should be collected for analysis. Diffusion samplers were discussed at the scoping meetings. Are diffusion samplers to be used?

Response: Section 4.3.3 will be clarified to state that micropurging techniques, consistent with those outlined in TtEMI SOP No. 15, will be the preferred sampling method for the PGDGI; however, standard well purging and sampling techniques, consistent with TtEMI SOP No. 10, may be used as field conditions warrant. In particular, the time required to achieve parameter stabilization, due to the fact that most wells have not been sampled in more than 4 years, may make micropurging techniques impractical. Regarding DTSC's specific comments on TtEMI SOP No. 15, the Navy is unclear as to what DTSC is referring to by requiring sampling rate on the sampling sheet included in the SOP. If the rate of purging is being referred to, then this rate is included on the sampling sheet under the discharge column. If the rate of filling sample containers is requested, then that rate is variable based on the size of the containers and can be ascertained by reading the COC. Further, sampling procedures for MNA parameters are specified in TtEMI SOP No. 15, with the exception of field measurements of ferrous iron. As stated in the Navy's response to comment 8 of the QAPP, information on the field test kit to be used for the PGDGI will be forwarded to DTSC. Section 4.3.3 will be clarified to refer the reader to the appropriate SOP for the required stabilization criteria. The Navy does not concur with DTSC's assessment that bailers cannot be used for the collection of MNA parameters, and will collect such parameters in accordance with the applicable SOPs. The use of an interface probe is not referred to in Section 4.3.3 of the FSP since it is not applicable to that portion of the PGDGI. In particular, the well inspection portion of the PGDGI utilized an interface probe at all wells to measure the potential presence of LNAPL and DNAPL. Further, free product recovery is being addressed under the petroleum hydrocarbon program. Finally, diffusion samplers will not be used during the PGDGI; however, they may be used to augment Phase II sampling efforts.

9. Comment: **Sample Analyses (Section 4.3.4). The order of sample collection is determined based on susceptibility to artificial aeration and should be explicitly stated for all methods used, including field sampling for MNA analytes. For example, semi-volatile organic compounds (SVOCs), total petroleum hydrocarbons-extractable range (TPH-e) and PCBs are given as the second batch in the sample collection order, followed by inorganics. Are these analytes (SVOCs, TPH-e and PCBs) more susceptible than the MNA analytes to artificial aeration? Only samples for CLP metals (dissolved) should be filtered.**

Response: Section 4.3.4 correctly refers to the appropriate sequence of sample collection including the MNA parameters specified on Table 4-4; however, the Navy is planning to add methane, ethane, and ethene to the analytical suite for MNA parameters (see response to comment 12 on the FSP). Samples for methane, ethane, and ethane will be collected following collection of samples for VOCs and purgeable petroleum hydrocarbons, and Section 4.3.3 will be revised accordingly.

10. Comment: <u>Analytical Program</u>. **"Target analytes" are identified on Table 4-5. The use of this phrase is confusing. The table should be corrected to say "Analytical Method/Reference," and should cite the Method/Reference in column 2 of Table 2-1 of the QAPP. It is DTSC's understanding that for the methods selected, all analytes in the method will be analyzed for and reported on. For example, all analytes of the CLP VOC and CLP SVOC methods will be reported, all analytes of the CLP Metals method will be reported. Analytes of concern should be noted in the column "Rationale for Resampling". Other comments on the analytical program are provided below. It is understood that other analytes and other wells may be added in Phase II.**

Response: The columns in Tables 4-5 and 4-6 titled "Target Analysis" typically list the general chemical categories identified for re-sampling; however, single analytes of concern are listed, as appropriate, based on the conclusions from the working meetings with the BCT in February and March 2000. Table 4-4 further details the broad chemical groups for each well proposed for sampling, and cross-references Tables 4-5 and 4-6, and Table 2-1 in the QAPP that specifies the laboratory method. To clarify, all analytes that are detected by the laboratory for a given method will be reported.

11. Comment: <u>Chromium VI (CrVI)</u>. **CrVI has been identified as a possible analyte of concern for the residential drinking water pathway. Where CrVI has been detected previously or where total Cr has been measured above the residential maximum permissible contaminant level (MCL) (50 mg/L), the wells should be resampled for both CrVI and metals (including total Cr).**

<u>Parcel C, RU-C1</u>. **Few groundwater samples have been analyzed for CrVI in Parcel C. According to the remedial investigation report (Attachment N-D), 7 samples in five wells (PA2852A, PA28MW50A, PA28MW51A, PA50MW03A, PA50MW04A) were analyzed for CrVI, with no detections of CrVI and no exceedences of the MCL for total Cr. However, this is a very small data set for a very large area, considering that CrVI is a known groundwater contaminant at the site, and that some soil samples were positive for CrVI on Parcel C. The fact that Cr has been detected (if at all) at low concentrations, suggests that Cr and CrVI in the groundwater of Parcel C is not naturally occurring. That is, it is unlikely to be associated with the native serpentinite soils. This indicates that all exceedences should be investigated as contamination. The following wells have exceedences of total Cr and should be added to the program for both CrVI and metals: IR28MW125A (250 mg/L), IR28MW294A (267 mg/L), and IR18MW155A (for an exceedence at nearby MW129A (51 mg/L) which currently has product).**

<u>Parcel D, RU-D1</u>. **To help determine lateral extent of CrVI and total chromium, additional wells should be added for RU-D1. For example, IR09MW37A had CrVI at 20 and 30 mg/L in latest samples (5/12/94 and 9/7/94) and so it is within the plume (i.e. the plume boundary should be redrawn to include this well). Other wells at the west and east periphery of the plume drawn on Figure 4-3 should be included in the analytical program for CrVI and for metals (including total Cr).**

Response: The Navy agrees that hexavalent chromium (Cr VI) was identified as a potential analyte of concern, at the working meetings with the BCT conducted in February and March 2000, and the Navy agrees to modify the sampling plan to include Cr VI analysis at Parcel C wells where chromium was identified as an analyte of concern (as discussed in the working meetings and summarized on Table 4-4 in the FSP). The Navy believes that, with the addition of the Cr VI analyses at Parcel C, the Cr VI sampling program adequately addresses the potential of Cr VI as a chemical of potential concern based on the objectives of the PGDGI.

The Navy acknowledges DTSC's comment for Parcel C; however, the Navy does not concur with DTSC's subsequent analysis, and wishes to clarify several issues raised by DTSC. First, DTSC's conclusion that Cr VI is a "known groundwater contaminant" is misleading in light of DTSC's initial comment that Cr VI is a "possible analyte of concern." Second, the Navy does not agree with DTSC's assessment that Cr VI concentrations in groundwater are unlikely to be associated with native serpentinite soils; rather, the Navy's position is that, based on the results of the PGDGI, additional evaluation of potentially naturally-occurring sources of Cr VI may be warranted. Finally, the Navy wishes to clarify that Cr VI concentrations are incorrectly referenced by DTSC throughout comment 11 as being in mg/L; the correct units for the concentrations referenced in comment 11 are μg/L.

The Navy does not concur with DTSC's recommendations for Parcel D. In particular, the Navy wishes to clarify that the revised RU boundaries were based on point exceedances of MCLs and HGALs. Well IR09MW37A was not included in RU-D1 since there was no exceedance of the MCL for total chromium; further, the Cr VI concentration is well below EPA's 1999 tap water preliminary remediation goal (109.5 μg/L). In addition, the Navy believes that the Cr VI sampling program at Parcel D adequately addresses the potential of Cr VI as a chemical of potential concern based on the objectives of the PGDGI.

12. **Comment:** **Monitored Natural Attenuation (MNA). The rationale for the specific parameters chosen is not provided (that is, a conceptual site model for MNA has not been proposed). For example, why has the Navy selected Nitrogen as N (not NO3)? Also, all parameters included in the MNA checklist have not been included. For example, methane, ethene, ethane, propane (degradation products of site contaminants) have not been included. The total petroleum hydrocarbon (TPH) analyses (i.e., modified 8015) should request quantification of these compounds. Section 4.3.4 and the footnote for Table 4-5 say that calcium, magnesium, sodium, and potassium are MNA parameters, but these analytes have not been addressed in the QAPP. Because of this discrepancy, it is not clear what the Navy's program includes. Please clarify. The methods to be used for these analytes should be addressed in the QAPP. Collection requirements should be included on Table 4-4. For demonstration of MNA, additional work will be required (see DTSC's MNA checklist previously provided).**

Response: As stated during the working meetings with the BCT, the Navy decided to collect MNA parameters to provide additional data for remedial design and technology evaluations, as appropriate; however, the focus of the data gaps investigation is not intended to include a detailed analysis of MNA. However, the Navy wishes to clarify several issues based on DTSC's comment. First, the Navy selected Nitrate (NO_3) as Nitrogen as specified in Table 4-4 of the FSP and 2-1 of the QAPP. Second, calcium, magnesium, sodium, and potassium were selected to aid in the MNA evaluation and will be included in the CLP metals analysis as specified in Table 2-1 of the QAPP. Third, the Navy feels that the collection requirements are adequately summarized on Table 2-1 of the QAPP that is referenced on Table 4-4. Finally, the Navy is planning to add methane, ethane, and ethene to the analytical suite for MNA parameters; Table 4-4 in the FSP and Table 2-1 in the QAPP will be revised accordingly.

13. Comment: **Well Installation. See FSP comment 5.**

Response: DTSC is referred to the Navy's response to comment 5 on the FSP.

14. Comment: **Aquifer Tests. One objective of the investigation is to understand the hydraulic relationship between aquifers A and B and to develop aquifer characteristics. However, no aquifer tests are proposed. How will the integrity of the aquitard between A and B aquifers be demonstrated?**

Response: No aquifer tests are proposed for the PGDGI; however, water level measurements from selected B-aquifer wells with adjacent A-aquifer wells—coupled with salinity measurements from each well—will be used to determine vertical gradients and provide a preliminary assessment of the hydraulic interaction between the A- and B-aquifers. Further analysis will likely be performed in conjunction with the Phase II sampling.

15. Comment: **Yield Data. The report should describe the procedures and the schedule for determining well yield.**

Response: Section 4.5 of the FSP will be revised to indicate that well development logs for the newly installed B-aquifer wells will be used to provide a preliminary assessment of whether the wells will meet the federal or state yield criteria. If the results indicate that the wells will not meet the yield criteria, a more detailed assessment will be conducted as part of Phase II.

16. Comment: **Sample Containerization, etc. (Section 6.2). A table showing methods, containerization, and preservation requirements (for field and lab analyses) should be included, since the FSP is meant to be a stand-alone document.**

Response: Table 2-1 in the QAPP summarizes the information specified in DTSC's comment, and is referenced in Table 4-4 of the FSP. The Navy would like to reiterate that the QAPP supplements the FSP, as stated in Section 1.0 of the FSP, and that it is duplicative to summarize information in both documents. Field crews are expected to have both the FSP and the QAPP on hand at all times, and the final version of the FSP and QAPP will be placed together in the same binder.

17. Comment: **Decontamination locations and storage locations for investigation-derived wastes (IDW) should be shown on a figure.**

Response: A figure(s) specifying the decontamination and IDW storage area will be included in the final FSP.

18. Comment: **Standard Operating Procedures (SOPs). The recommended approach for FSPs is to include detailed description only of the tasks proposed. This cannot be overemphasized. For example, multiple approaches and forms are included in these SOPs and in the QAPP. This is confusing and requires unnecessary extra work. Moreover, it is not clear what will actually be done in the field. It is assumed that the QAPP forms will be used in this investigation. Similarly it is assumed that Tetra Tech's SOPs apply for well sampling, well development, etc. Tetra Tech EM Inc. and International Technologies Corporation (IT) SOPs have not been reviewed in detail, since they contain general information on methods not proposed for this investigation. Nonetheless some comments are provided regarding SOP 015 (see FSP comment 8), and for other SOPs below.**

SOP 002. For wells with DNAPL or LNAPL, solvent washes will be required for DNAPLs and LNAPLs (as in Section 2.5). Similarly, metals contamination, a dilute nitric acid rinse will be required.

SOP 010. Guidance for when to use the interface probe should be included in this SOP (and in SOP 014). This SOP should also include the micropurging option and refer to the micropurging SOP. Turbidity measurement and stabilization is a RCRA requirement as well as a general DTSC requirement and should be included in Table 2. It is not clear why the stabilization criteria in this SOP are different from those in SOP 015.

Response: The Navy wishes to clarify that the SOPs referenced in the FSP are intended to provide additional detail for the field activities specified in the FSP. Please refer to the Navy's responses to comment 6 on the QAPP and comment 8 on the FSP for further clarification. The TtEMI and IT Corporation SOPs may include information that is not applicable to the PGDGI. However, this additional information is necessary for the SOPs to be applied to a wide range of projects performed by TtEMI and IT Corporation, and it is not practical to modify these SOPs in order to facilitate agency review for a specific project. As stated in the FSP, the TtEMI SOPs are applicable to the well inspection, water level measurement, and well sampling activities and the IT Corporation SOPs are applicable to the well installation and development activities.

The decontamination procedures referenced in DTSC's comment are currently specified in TtEMI SOP No. 2. For clarification on DTSC's comment on TtEMI SOP No. 010, please refer to the Navy's response to comment 8 on the FSP.

19. Comment: **Appendix B. Why are IT SOPs included? IT is not mentioned in the QAPP. Who is responsible for the "Responsibilities" sections of the IT SOPs?**

SOP 8.1. It is assumed that the Tetra Tech EM Inc.'s Monitoring Well Completion Record of the QAPP is to be used in lieu of IT's Attachment 6.3: Example Well completion Form, which is not acceptable to DTSC.

SOP 8.2. It is assumed that Tetra Tech EM Inc.'s forms in the QAPP are used in lieu of IT's attachments to this SOP.

SOP 11.1. This IT SOP for aquifer testing is included but no aquifer testing is described in the text.

SOP 8.3. This SOP which describes grouting of boreholes is not included. How will boreholes be grouted?

Response: The IT Corporation SOPs are included as referenced in the Sections 4.4 and 4.5 of the FSP because IT Corporation will conduct the well installation and development activities. The monitoring well completion record included in the QAPP will be used in place of the record referenced in IT Corporation SOP 8.1. Appendix 1 of the QAPP does not include a well development record, and the record included as Attachment 6.1 of IT Corporation SOP 8.2 will be used. IT Corporation SOP 11.1 will be removed from the FSP since no aquifer testing is proposed for the PGDGI. As noted in the Navy's response to comment 5 on the FSP, pilot borings will not be used in the PGDGI; therefore, SOP 8.3 does not apply to the PGDGI.

20. Comment: Well Logs (Attachment C). Why are the well logs included in this FSP?

Response: Well logs were included to be consistent with the FSP/QAPP for the Parcel B Remedial Action Monitoring Plan.

21. Comment: Schedule of Work (Table 8-1). All components of the proposed work are not included on this schedule. For example, water level measurement events are not included, and well investigation and corrective action are not included, and the report for phase I investigation is not included.

Response: Table 8-1 will be revised to include the information requested by DTSC, and other pertinent schedule dates for the PGDGI.

22. Comment: Phase I Groundwater Data Gap Report. The scope of work for the report and the schedule for the report should be discussed with the agencies.

Response: A new section will be added to the FSP to discuss reporting of the PGDGI results. In particular, water level and water quality data gathered from the PGDGI will be presented to the BCT in an information package similar to the package provided for the working meetings conducted in February and March 2000. The BCT's evaluation of that information will be incorporated into the revised feasibility study (FS) for Parcel C. In addition, following the completion of Phase II of the groundwater data gaps investigation, the groundwater areas proposed for evaluation in the FS will be specified in a beneficial use letter.

23. Comment: Figures 4-1 to 5. Building numbers should be added to figures so that the references to buildings in the text can be understood. Similarly, IR site boundaries should be indicated.

Response: Building numbers and IR site boundaries will be included in the revised Figures 4-1 through 4-5 in the FSP.

24. Comment: **<u>Figure 4-2</u>. The descriptor "wells not available for sampling" should be changed, since this represents the Navy's opinion but not necessarily the opinion of DTSC (see FSP comment 5). Wells with product should be distinguished from those abandoned. Similarly, missing wells and wells for which additional survey data are needed should be distinguished from abandoned wells. The extent of contamination at RU-C5 should include all exceedences, including those on adjacent Parcel B. However, it is understood that the boundary line will be re-drawn after sampling results are received. The convention for boundary lines that are not determined/are disputed, is for such lines to be dashed and/or queried.**

Response: Figure 4-1 is intended to report the locations for the basewide water level measurement and confirmation land survey, and is not intended to summarize the results of the well condition survey. Table 4-2 of the FSP adequately summarizes the results of the well condition survey and specifies the sub-categories contained under the category "wells not available for sampling." In addition, the RU boundaries on Figures 4-2 through 4-5 will be further clarified.

25. Comment: **<u>Figure 4.3</u>. IR09MW37A should be within the plume boundary (see FSP comment 6).**

Response: Please refer to the Navy's response to comment 11 on the FSP.

APPENDIX C

STANDARD OPERATING PROCEDURES – Tetra Tech EM Inc.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GENERAL EQUIPMENT DECONTAMINATION

SOP NO. 002

REVISION NO. 2

Last Reviewed: December 1999

February 2, 1993

Quality Assurance Approved

Date

1.0 BACKGROUND

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

1.2 SCOPE

This SOP applies to decontaminating general nondisposable field equipment. To prevent contamination of samples, all sampling equipment must be thoroughly cleaned prior to each use.

1.3 DEFINITIONS

Alconox: Nonphosphate soap

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992. "RCRA Ground-Water Monitoring: Draft Technical Guidance. Office of Solid Waste. Washington, DC. EPA/530-R-93-001. November.

EPA. 1994. "Sampling Equipment Decontamination." Environmental Response Team SOP #2006 (Rev. #0.0, 08/11/94). On-Line Address: http://204.46.140.12/media_resrcs/media_resrcs.asp?Child1=

1.5 REQUIREMENTS AND RESOURCES

The equipment required to conduct decontamination is as follows:

- Scrub brushes
- Large wash tubs or buckets
- Squirt bottles

- Alconox
- Tap water
- Distilled water
- Plastic sheeting
- Aluminum foil
- Methanol or hexane
- Dilute (0.1 N) nitric acid

2.0 PROCEDURE

The procedures below discuss decontamination of personal protective equipment (PPE), drilling and monitoring well installation equipment, borehole soil sampling equipment, water level measurement equipment, and general sampling equipment.

2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off-site or to clean areas. All used disposable protective clothing, such as Tyvek coveralls, gloves, and booties, will be containerized for later disposal. Decontamination water will be containerized in 55-gallon drums.

Personnel decontamination procedures will be as follows:

1. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.

2. Wash outer gloves in Liquinox or Alconox solution and rinse in clean water. Remove outer gloves and place into plastic bag for disposal.

3. Remove Tyvek or coveralls. Containerize Tyvek for disposal and place coveralls in plastic bag for reuse.

4. Remove air purifying respirator (APR), if used, and place the spent filters into a plastic bag for disposal. Filters should be changed daily or sooner depending on use and application. Place respirator into a separate plastic bag after cleaning and disinfecting.

5. Remove disposable gloves and place them in plastic bag for disposal.

6. Thoroughly wash hands and face in clean water and soap.

2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling equipment should be decontaminated at a designated location on-site before drilling operations begin, between borings, and at completion of the project.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they should be steam cleaned on-site prior to placement downhole. The drilling subcontractor will typically furnish the steam cleaner and water.

After cleaning the drilling equipment, field personnel should place the drilling equipment, well casing and screens, and any other equipment that will go into the hole on clean polyethylene sheeting.

The drilling auger, bits, drill pipe, temporary casing, surface casing, and other equipment should be decontaminated by the drilling subcontractor by hosing down with a steam cleaner until thoroughly clean. Drill bits and tools that still exhibit particles of soil after the first washing should be scrubbed with a wire brush and then rinsed again with a high-pressure steam rinse.

All wastewater from decontamination procedures should be containerized.

2.3 BOREHOLE SOIL SAMPLING EQUIPMENT DECONTAMINATION

The soil sampling equipment should be decontaminated after each sample as follows:

1. Prior to sampling, scrub the split-barrel sampler and sampling tools in a bucket using a stiff, long bristle brush and Liquinox or Alconox solution.

2. Steam clean the sampling equipment over the rinsate tub and allow to air dry.

3. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.

4. Containerize all water and rinsate.

5. Decontaminate all pipe placed down the hole as described for drilling equipment.

2.4 WATER LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION

Field personnel should decontaminate the well sounder and interface probe before inserting and after removing them from each well. The following decontamination procedures should be used:

1. Wipe the sounding cable with a disposable soap-impregnated cloth or paper towel.
2. Rinse with deionized organic-free water.

2.5 GENERAL SAMPLING EQUIPMENT DECONTAMINATION

All nondisposable sampling equipment should be decontaminated using the following procedures:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of protection as was used for sampling.
3. To decontaminate a piece of equipment, use an Alconox wash; a tap water wash; a solvent (methanol or hexane) rinse, if applicable or dilute (0.1 N) nitric acid rinse, if applicable; a distilled water rinse; and air drying. Use a solvent (methanol or hexane) rinse for grossly contaminated equipment (for example, equipment that is not readily cleaned by the Alconox wash). The dilute nitric acid rinse may be used if metals are the analyte of concern.
4. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
5. Containerize all water and rinsate.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GROUNDWATER SAMPLING

SOP NO. 010

REVISION NO. 3

Last Reviewed: March 2000

Quality Assurance Approved

February 19, 1993

Date

1.0 BACKGROUND

Groundwater sampling may be required for a variety of reasons, such as examining potable or industrial water supplies, checking for and tracking contaminant plume movement in the vicinity of a land disposal or spill site, Resource Conservation and Recovery Act (RCRA) compliance monitoring, or examining a site where historical information is minimal or non-existent, but where groundwater may be contaminated.

Groundwater is usually sampled through an in-place well, either temporarily or permanently installed. However, it can also be sampled anywhere groundwater is present, such as a pit or a dug or drilled hole.

Occasionally, a well will not be in the preferred location to obtain the sample needed (for example, to track a contaminant plume). In such a case, a temporary or permanent well will have to be installed. An experienced and knowledgeable person, preferably a hydrogeologist, will need to locate the well and supervise its installation so that the samples ultimately collected will be representative of the groundwater. SOP No. 020 (Monitoring Well Installation) provides guidance for installing new monitoring wells.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for determining the quality of groundwater entering, leaving, or affected by site activities through groundwater sampling. The samples are obtained by retrieving water from a well screened in the aquifer(s) underlying a site.

1.2 SCOPE

This SOP provides general guidance for groundwater sampling activities conducted in the field. SOP No. 015 (Groundwater Sample Collection Using Micropurge Technology) provides additional specific guidance for using low flow methods to collect groundwater samples.

1.3 DEFINITIONS

Bailer: A cylindrical sampling device with valves on either end used to extract water from a well. Bailers are usually constructed of an inert material such as stainless steel or polytetrafluoroethylene (Teflon). The bailer is lowered and raised by means of a cable that may be cleaned and reused, or by disposable rope.

Electrical Water Level Indicator: An electrical device that has a light or sound alarm connected to an open circuit used to determine the depth to liquid. The circuit is closed when the probe intersects a conducting liquid. The wire used to raise and lower the probe is usually graduated.

Immiscible Phase: Liquid phases that cannot be uniformly mixed or blended with water. Heavy immiscible phases sink, and light immiscible phases float on water.

Interface Probe: An electrical probe that determines the distance from the surface to air/water, air/immiscible, or immiscible/water interfaces.

Purge Volume: The volume of water that needs to be removed from the well prior to sampling to ensure that the sample collected is representative of the groundwater.

Riser Pipe: The length of well casing above the ground surface.

Total Well Depth: The distance from the ground surface to the bottom of the well.

Water Level: The level of water in a well, measured as depth to water or as elevation of water, relative to a reference mark or datum.

1.4 REFERENCES

U.S. Department of Energy. 1985. "Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells: Second Edition." Edited by N. Korte and P. Kearl. Technical Measurements Center, Grand Junction Projects Office. GJ/TMC-08.

U.S. Environmental Protection Agency (EPA). 1977. "Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities." EPA-530/SW-611. August.

EPA. 1984. "Sampling at Hazardous Materials Incidents." EPA Hazardous Response Support Division, Cincinnati, 1984.

EPA. 1995. "Groundwater Well Sampling." Environmental Response Team SOP #2007 (Rev. #0.0, 01/26/95). On-Line Address: http://204.46.140.12/media_resrcs/media_resrcs.asp?Child1=

U.S. Geological Survey. 1984. "National Handbook of Recommended Methods for Water-Data Acquisition" Reston, Virginia.

1.5 REQUIREMENTS AND RESOURCES

There are various options available to obtain groundwater samples. The procedures are outlined in the following section. The equipment needed to accomplish these procedures includes the following:

- Organic vapor detector with a flame ionization detector (FID) or a photoionization detector (PID)
- Pipe wrench
- Electrical water level indicator or interface probe
- Steel tape with heavy weight
- Purging device (type needed depends on well depth, casing diameter, and type of sample desired; see sampling devices below)
- Sampling device (type needed depends upon depth to water and type of sample desired)
  - Teflon bailer
  - Stainless steel bailer
  - Teflon bladder pump
  - Stainless steel submersible (nonoil-bearing) pump

  - Existing dedicated equipment
  - Peristaltic pump

- Sample containers

- Wastewater containers

- Field logbook

- Stopwatch

Additional equipment is required to complete measurement of field parameters (for example, pH, specific conductance, and temperature) of the groundwater in the well.

2.0 PROCEDURE

Prior to sampling, a site-specific sampling plan should be developed. The plan should take into consideration the site characteristics and should include:

- Specific repeatable well measurement techniques and reference points for determining the depth to water and the depth to the bottom of the well

- Specific method of purging and selection of purging equipment

- Specific methods and equipment for measurements of field parameters

- Specific method of sample collection and the sampling equipment that will be used

- Specific parameters for which samples will be analyzed

- Order in which sample bottles will be filled, based on the analytical parameters

The following sections discuss procedures for approaching the well, establishing a sample preparation area, making preliminary well measurements, purging the well, and collecting samples.

2.1 APPROACHING THE WELL

In general, all wells should be assumed to pose a health and safety risk until field measurements indicate otherwise. Approach wells from the upwind side. Record well appearance and general condition of the protective casing, surface seal, and surrounding area in the logbook.

Once at the well, the lead person should systematically use the organic vapor detector to survey the immediate area around the well (from the breathing zone to the top of the casing to the ground). If elevated FID and PID meter readings are encountered, retreat to a safe area and instruct the sampling team to put on the appropriate level of personal protective equipment (PPE). See SOP No. 003 (Organic Vapor Air Monitoring) for additional guidance.

Upon opening the well casing, the lead person should systematically survey inside the well casing, above the well casing in the breathing zone and the immediate area around the well. If elevated FID or PID meter readings in the breathing zone are encountered (see health and safety plan for action levels), retreat and put on appropriate PPE. It is important to remember that action levels are based on readings in the breathing zone, not within the well casing. Representative organic vapor detector readings should be recorded in the logbook.

2.2 ESTABLISHING A SAMPLE PREPARATION AREA

The sample preparation area is generally located upwind or to either side of the well. If elevated readings are encountered using an organic vapor detector, this area should be taped off and the sample preparation area should be located upwind where ambient readings are found.

2.3 MAKING PRELIMINARY WELL MEASUREMENTS

Several preliminary well measurements should be made prior to initiating sampling of the well. These include determining water level and total well depth measurements, determining the presence of immiscible phases, and calculating purge volumes. All preliminary measurements will be recorded in the logbook as they are determined. SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement) provides additional information concerning these preliminary measurements.

2.3.1 Water Level and Total Well Depth Measurements

Tetra Tech typically uses an electric water level indicator for water level measurements. This device sounds an alarm or illuminates a light when the measuring probe touches the water surface, thus closing an electrical circuit. The electric cable supporting the probe is usually graduated in feet and can be read at the well site directly. The remaining fraction is measured with a steel tape graduated to 0.01 foot. The distance between the static water level and the marked or notched location at the top of the riser pipe is measured. The height of the riser pipe above ground surface, as obtained from well location survey data, is then subtracted from the total reading to give the depth to static water. To improve accuracy, three separate readings should be made, and the values averaged. This helps to eliminate any errors due to kinks or bends in the cables, which may change in length when the water level indicator is raised and lowered.

The total well depth can be measured by using a steel tape with a heavy weight attached to the end. The tape is lowered into the well until resistance is met, indicating that the weight has reached the bottom of the well. The total well depth is then read directly from the steel tape to the 0.01-foot fraction. The distance between the bottom of the well and the marked or notched location on the riser pipe is measured. The height of the riser pipe above the ground surface, as obtained from well survey data, is then subtracted from the total reading to give the depth to the bottom of the well. To improve accuracy, three separate readings should be made, and the readings averaged.

2.3.2 Determining If Immiscible Phases Are Present

If immiscible phases (organic floaters or sinkers) are present, the following measurement activities should be undertaken. Organic liquids are measured by lowering an interface probe slowly to the surface of the liquid in the well. When the audible alarm sounds, record the depth. If the alarm is continuous, a floating immiscible layer has been detected. To determine the thickness of this layer, continue lowering the probe until the alarm changes to an oscillating signal. The oscillating signal indicates that the probe has detected an aqueous layer. Record this depth as the depth to water and determine the thickness and the volume of the immiscible layer.

Continue lowering the probe into the well to determine if dense immiscible phases (sinkers) are present. If the alarm signal changes from oscillating to a continuous sound, a heavier immiscible layer has been detected; record this depth.

Continue lowering the probe to the bottom of the well and record the total depth. Separate total depth measurements with a steel tape are not necessary when using an interface probe. Calculate and record the sinker phase volume and total water volume in the well. A chart is provided in Table 1 to assist in these calculations. If immiscible phases are present, immediately refer to Section 2.5.3 or 2.5.4 of this SOP.

2.3.3 Determination of Purging Volume

If the presence of floaters or sinkers does not need to be determined, determine the depth to water and the total depth of the well as described in Section 2.3.1. Once these measurements have been made and recorded, use Table 1 to calculate the total volume of water in the well. Multiply this volume by the purging factor to determine purging volume. The minimum purging factor is typically three casing volumes but may be superseded by site-specific program requirements, individual well yield characteristics, or stabilization of field parameters measured during purging. Field parameters (for example, pH, specific conductance, and temperature) should be measured prior to purging and after each well volume. All field parameter data should be recorded in the field logbook. SOPs No. 011 (Field Measurement of Water Temperature), 012 (Field Measurement of pH), and 013 (Field Measurement of Specific Conductance) include more detailed procedures for determining these field parameters.

In Table 1, the volume of water in a 1-foot section of a 2-inch-diameter well is 0.163 gallon. This chart can easily be used for any water depth by multiplying all the values in Table 1 by the L value (depth, in feet, of water in the well). The volume of water in the well is based on the following formula:

$$V = \frac{\pi \times D^2}{4} \times L$$

where

V = volume of water in the well (cubic feet)

D = inside diameter of the well (feet)

L = depth of water in the well (feet)

2.4 PURGING THE WELL

Currently, Tetra Tech standards allow for six options for purging wells:

1. Teflon bailers
2. Stainless steel bailers
3. Teflon bladder pumps
4. Stainless steel submersible (nonoil-bearing) pumps
5. Existing dedicated equipment
6. Peristaltic pumps (these devices are for shallow wells only)

As previously stated, the minimum purging volume is typically three casing volumes. Exceptions to this standard may be made in the case of low-yield wells. When purging low-yield wells, purge the well once to dryness. Samples should be collected as soon as the well recovers. When the time required for full recovery exceeds 3 hours, samples should be collected as soon as sufficient groundwater volume is available.

The well should be purged until measured field parameters have stabilized. If any field parameter has not stabilized, additional purging should be performed. To be considered stable, field parameters should change by no more than the tolerance levels listed on Table 2 between each well volume purged.

At no time should the purging rate be high enough to cause the groundwater to cascade back into the well, resulting in excessive aeration and potential stripping of volatile constituents.

The actual volume of purged water can be measured using several acceptable methods:

- When bailers are used, the actual volume of each bailer's contents can be measured using a calibrated bucket.
- If a pump is used for purging, the pump rate can be determined by using a bucket of known volume, stopwatch, and the duration of pumping time necessary to purge the known volume.

2.5 SAMPLE COLLECTION

This section first describes general groundwater sample collection procedures. This section also describes procedures for collecting groundwater samples for volatile organic analysis (VOA) and for collecting samples when light or heavy immiscible layers are present in a monitoring well. Samples of light and heavy immiscible layers should be collected before the well is purged.

2.5.1 General Groundwater Sampling Procedures

The technique used to withdraw a groundwater sample from a well should be selected based on the parameters for which the sample will be analyzed. To ensure that the groundwater samples are representative, it is important to avoid physically altering or chemically contaminating the sample during collection, withdrawal, or containerization. If the samples are to be analyzed for volatile organic compounds, it is critical that air does not become entrained in the water column.

Acceptable sampling devices for all parameters are double check valve stainless steel or Teflon bailers, bladder pumps, low-flow positive displacement pumps, or for shallow wells, peristaltic pumps. Additional measurements of field parameters should be performed at the time of sampling.

In some cases, it may become necessary to use dedicated equipment already in the well to collect samples. This is particularly true of high volume, deep wells (>150 feet) where bladder pumps are ineffective and bailing is impractical. If existing equipment must be used, however, determine the make and model of the pump and obtain information on component construction materials from the manufacturer or facility representatives. If an existing pump is to be used for sampling, make sure the flow volume can be reduced so that a reliable VOA sample can be taken. Record the specific port, tap, or valve from which the sample is collected.

General sampling procedures include the following:

- Clean sampling equipment should not be placed directly on the ground. Use a plastic drop cloth or feed line from clean reels. Never place contaminated lines back on reels.

- Check the operation of the bailer check valve assemblies to confirm free operation.

- If the bailer cable is to be decontaminated and reused, it must be made of Teflon-coated stainless steel.

- Lower sampling equipment slowly into the well to avoid degassing the water and damaging the equipment.

- Pump flow rates should be adjusted to eliminate intermittent or pulsed flow. The settings should be determined during the purging operations.

- A separate sample volume should be collected to measure necessary field parameters. Samples should be collected and containerized in the order of the parameters' volatilization sensitivity. Table 3 lists the preferred collection order for common groundwater parameters.

Intermediate containers should never be used to prepare VOA samples and should be avoided for all parameters in general. All VOA containers should be filled at a single sampling point or from a single bailer volume.

2.5.2 Collection of Volatile Organics Samples

This section discusses the collection of samples for VOA using either a bailer or bladder pump in detail. Other pumps (such as positive displacement or peristaltic) can be used. The following factors are critical to the collection of representative samples for VOA: ensuring that no air has become entrained in the water column, low pump flow rates (less than 100 milliliter [mL] per minute, if possible), and avoiding flow surges.

2.5.2.1 Collection with Bailers

Samples for VOA should be collected from the first bailer removed from the well after purging. The most effective means requires two people. One person should retrieve the bailer from the well and pour its contents into the appropriate number of 40-mL VOA vials held by the second person. Cap each vial and invert it. If a bubble exists, unscrew the cap and add more water, or discard and repeat. The sample should be transferred from the bailer to the sample container in a manner that will limit the amount of agitation in order to reduce the loss of volatile organics from the sample.

Always fill VOA vials from a single bailer volume. If the bailer is refilled, samples cannot be considered duplicates or splits.

2.5.2.2 Collection with a Bladder Pump (Well Wizard)

To successfully perform VOA sampling with a Well Wizard bladder pump, the following steps must be completed:

1. Following manufacturer's directions, activate the pump. Full water flow from the discharge tubing will begin after 5 to 15 pumping cycles. These initial pumping cycles are required to purge air from the pump and discharge tubing. The discharge and recharge settings must be manually set and adjusted to pump at optimum flow rates. To activate the bladder, it is best to set the initial cycle at long discharge and recharge rates.

2. Reduce water flow rate for VOA sample collection. To reduce the water flow rate, turn the throttle control valve (located on the left side of the Well Wizard pump control panel) counterclockwise.

3. Collect VOA sample from discharge tubing. VOA vials must be placed beneath the discharge tubing while avoiding direct contact between the vials and the tubing. Never place tubing past the mouth of the VOA vial. The pump throttle control must be turned as necessary to maintain a trickle of water in order to obtain a meniscus in the vial.

4. Continue with non-VOA sampling. Increase pump flow rate by turning the throttle control knob clockwise.

2.5.3 Collection of Light Immiscible Floaters

The approach used when collecting floaters depends on the depth to the floating layer and the thickness of that layer. If the thickness of the floater is 2 feet or greater, a bottom-filling valve bailer should be used. Slowly lower the bailer until contact is made with the floater surface, and lower the bailer to a depth less than that of the floater/water interface depth as determined by preliminary measurements with the interface probe.

When the thickness of the floating layer is less than 2 feet, and the depth to the surface of the floating layer is less than 15 feet, a peristaltic pump can be used to extract a sample.

When the thickness of the floating layer, however, is less than 2 feet and the depth to the surface of the floating layer is beyond the effective "lift" of a peristaltic pump (greater than 25 feet), a bailer can be modified to allow filling from the top only (an acceptable alternative is to use a top- loading Teflon or stainless-steel bailer). Disassemble the bailer's bottom check valve and insert a piece of 2-inch diameter Teflon sheet between the ball and ball seat. This will seal off the bottom valve. Remove the ball from the top check valve, thus allowing the sample to enter from the top. To overcome buoyancy when the bailer is lowered into the floater, place a length of one-inch stainless steel pipe on the retrieval line above the bailer (this pipe may have to be notched to allow sample entry if the pipe remains within the top of the bailer). As an alternative, use a top-loading stainless-steel bailer. Lower the device, carefully measuring the depth to the surface of the floating layer, until the top of the bailer is level with the top of the floating layer. Lower the bailer an additional one-half thickness of the floating layer and collect the sample. This technique is the most effective method of collection if the floating layer is only a few inches thick.

2.5.4 Collection of Heavy Immiscible Sinkers

The best method for collection of sinkers is use of a double check valve bailer. The key to collection is controlled, slow lowering and raising of the bailer to and from the bottom of the well. Collection methods are equivalent to those described in Section 2.5.3 above.

TABLE 1

LIQUID VOLUME IN A 1-FOOT SECTION OF WELL CASING

Well Casing Inside Diameter (D) (inches)	Volume of Liquid in 1-Foot Well Section (gallons) $V= 0.0408 (D^2)$
1	0.041
1.5	0.092
2	0.163
3	0.367
4	0.653

TABLE 2

FIELD MEASUREMENT TOLERANCE LEVELS

Field Parameter	Tolerance Level
pH	0.1 pH unit
Specific Conductance	10 percent relative percent difference (RPD)[a]
Temperature	1 °C

Note:

[a] RPD can be determined as follows:

$$RPD = \frac{(\text{Measurement 1} - \text{Measurement 2}) \times 100}{(\text{Measurement 1} + \text{Measurement 2}) / 2}$$

TABLE 3

ORDER OF PREFERRED SAMPLE COLLECTION

1. VOA
2. Purgeable organic halogens (POX)
3. Total organic halogens (TOX)
4. Cyanide
5. Extractable organics
6. Purgeable organic carbon (POC)
7. Total metals
8. Dissolved metals
9. Total organic carbon (TOC)
10. Phenols
11. Sulfate and chloride
12. Nitrate and ammonia
13. Radionuclides

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

STATIC WATER LEVEL, TOTAL WELL DEPTH, AND IMMISCIBLE LAYER MEASUREMENT

SOP NO. 014

REVISION NO. 0

Last Reviewed: December 1999

RRiesing

Quality Assurance Approved

July 20, 1994

Date

1.0 BACKGROUND

Measurement of static water level, total well depth, and any immiscible layers is necessary before a well can be sampled and groundwater flow direction can be determined. If an immiscible layer is present, its depth and thickness must be determined. In addition, the static water level and total depth of a monitoring well are needed to determine a purging volume.

1.1 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide guidelines for field personnel measuring static water levels and total water depths of monitoring wells or piezometers. This SOP also provides guidelines for measuring immiscible layers in such wells.

1.2 SCOPE

This SOP describes the methodologies for measuring static water level, total well depth, and immiscible layer depth and thickness.

1.3 DEFINITIONS

To clarify the methodologies presented in this SOP, the following definitions are presented:

Electrical Water Level Indicator: An electrical probe used to determine the depth to fluid. The probe has a light or sound alarm connected to an open circuit. The circuit is closed and the alarm is activated when the probe contacts a conducting fluid such as water.

Immiscible Layer: A liquid phase that cannot be uniformly mixed or blended with water. Heavy immiscible phases sink in water; light immiscible phases float on water.

Interface Probe: An electrical probe used to determine the thicknesses of light or dense immiscible layers in the water column of a monitoring well.

Ionization Detector: A photoionization detector (PID) or a flame ionization detector (FID) is used to measure the level of volatile organic compounds in the gaseous phase. These units are generally not compound-specific and thus measure only total volatile organic compounds. The PID generally cannot detect as complete a range of compounds as the FID. This difference is the result of the relative ionization energies of the two detectors. Most PIDs cannot detect methane, but FIDs can. The HNu and Microtip are examples of PIDs; the Foxboro organic vapor analyzer (OVA) is an example of an FID.

Static Water Level: The level of water in a monitoring well or piezometer. This level can be measured as the depth to water or as the elevation of water relative to a reference mark or datum.

Total Well Depth: The distance from the ground surface to the bottom of a monitoring well or piezometer

1.4 REFERENCES

SOP No. 002, General Equipment Decontamination

U.S. Environmental Protection Agency. 1994. "Water Level Measurement." Environmental Response Team SOP #2043 (Rev. #0.0, 10/03/94). On-Line Address: http://204.46.140.12/media_resrcs/media_resrcs.asp?Child1=

1.5 REQUIREMENTS AND RESOURCES

The equipment required for measuring static water levels, total well depths, and immiscible layers is as follows:

- Electrical water level indicator
- Interface probe
- PID or FID

2.0 PROCEDURES

This section provides general guidance followed by specific procedures for static water level, total well depth, and immiscible layer measurement.

Techniques for measuring depth to water and depth to the bottom of a monitoring well should be identified in the planning stage of field work. Also at this stage, measuring devices should be chosen, and an individual should be assigned to take and record measurements.

All measurement instruments should be decontaminated before and after use and between measurement locations. Refer to SOP No. 002, General Equipment Decontamination.

Before initiating any measuring activities, the ambient air at a monitoring well head should be monitored for possible emissions of volatile organic compounds. To accomplish this monitoring, a PID or an FID should be used. The health and safety plan for on-site activities should provide action levels and the rationale for selection of either detector.

Appropriate respiratory protection equipment should be worn by the sampling team. Wells should be approached from the upwind side. When opening the monitoring well, the sampling team should systematically survey the inside of the well casing, the area from the casing to the ground, the area from above the well casing to the breathing zone, and the area around the well. Readings for comparison to action levels should be taken not within the well casing but in the breathing zone. If PID or FID readings of volatile organic compounds are above action levels, the sampling team should retreat to a safe area and put on appropriate safety gear. The site-specific health and safety plan should be consulted for action levels.

2.1 STATIC WATER LEVEL MEASUREMENT

The procedure described below should be followed to measure the static water level in a monitoring well or piezometer.

An electric water level indicator is typically used for static water level measurement. The electrical probe of the indicator should be lowered into the monitoring well until the light or sound alarm is activated, indicating that the probe has touched the water surface. The static water level should then be read directly from the indicator to the 0.01-foot fraction. If the monitoring well top is not flush with the ground surface, the distance between the static water level and the top of the riser pipe should be measured; the height of the riser pipe above ground surface should then be subtracted from the first measurement to determine the depth to static water below ground surface. If surveyed elevations are available, they should be used to establish the water level elevation. To ensure measurement accuracy, the probe should be left hanging above the water surface in the monitoring well; a series of three readings should be taken, and the values should be averaged. The measurement date and time, individual readings, and the average of the readings should be recorded in a field logbook.

2.2 TOTAL WELL DEPTH MEASUREMENT

The procedure described below should be followed to measure total well depth in a monitoring well or piezometer.

Total well depth measurement can be performed also using an electric water level indicator. The electrical probe of the indicator should be lowered into the monitoring well until resistance is met, indicating that the probe has reached the bottom of the well. The total well depth should then be read directly from the indicator to the 0.01-foot fraction. If the monitoring well top is not flush with the ground surface, the distance between the bottom of the well and the top of the riser pipe should be measured; the height of the riser pipe above ground surface should then be subtracted from the first measurement to determine the depth from ground surface to the bottom of the well. To ensure measurement accuracy, the probe should be left hanging above the water surface in the monitoring well; a series of three readings should be taken, and the values should be averaged. The measurement date and time, individual readings, and the average of the readings should be recorded in a field logbook.

2.3 IMMISCIBLE LAYER DETECTION AND MEASUREMENT

The procedure described below should be followed to detect and measure an immiscible layer in a monitoring well.

A light immiscible layer in a monitoring well can be detected by slowly lowering an interface probe to the surface of the water in the well. When the audible alarm sounds, the depth of the probe should be recorded. If the alarm is continuous, a light immiscible layer has been detected. To measure the thickness of this layer, the probe should then be lowered until the alarm changes to an oscillating signal. The oscillating alarm indicates that the probe has reached a water layer. The probe depth at the time the alarm begins oscillating should be recorded as the depth to water. The thickness of the light immiscible layer should then be determined by subtracting the depth at which a continuous alarm occurred from the depth at which the alarm began to oscillate. To ensure measurement accuracy, the interface probe should be left hanging above the water surface in the monitoring well; a series of three readings should be taken, and the depths and thicknesses measured should be averaged. The measurement date and time, individual readings for depth and thickness, and average values for depth and thickness should be recorded in a field logbook.

To determine whether a dense immiscible layer is present, the interface probe should be lowered further into the monitoring well. If the alarm changes from an oscillating to a continuous signal, a heavier immiscible layer has been detected, and the probe depth should be recorded at that point. Total well depth obtained in Section 2.2 should be used for calculating the thickness of the dense layer. The dense layer should be calculated by subtracting the depth at which the alarm became continuous from the total well depth. This procedure provides an estimate of the thickness of the dense layer in the monitoring well. To ensure measurement accuracy, the interface probe should be left hanging above the water surface in the monitoring well; a series of three readings should be taken, and the depths and thicknesses measured should be averaged. The measurement date and time, individual readings for depth and thickness, and average values for depth and thickness should be recorded in a field logbook.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GROUNDWATER SAMPLE COLLECTION USING MICROPURGE TECHNOLOGY

SOP NO. 015

REVISION NO. 0

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RRiesing

Quality Assurance Approved

April 7, 1998

Date

1.0 BACKGROUND

Groundwater sample collection is an integral part of site characterization at many contaminant release investigation sites. Often, a requirement of groundwater contaminant investigation is to evaluate contaminant concentrations in the aquifer. Since data quality objectives of most investigations require a laboratory setting for chemical analysis, samples must be collected from the aquifer and submitted to a laboratory for analysis. Therefore, sample collection and handling must be conducted in a manner that minimizes alteration of chemical characteristics of the groundwater.

In the past, most sample collection techniques followed federal and state guidance. Acceptable protocol included removal of water in the casing of a monitoring well (purging), followed by sample collection. The water in the casing was removed so groundwater from the formation could flow into the casing and be available for sample collection. Sample collection was commonly completed with a bailer, bladder pump, controlled flow impeller pump, or peristaltic pump. Samples were preserved during collection. Often, samples to be analyzed for metals contamination were filtered through a 0.45-micron filter prior to preservation and placement into the sample container.

Research conducted by several investigators has demonstrated that a significant component of contaminant transport occurs while the contaminant is sorbed onto colloid particles. Colloid mobility in an aquifer is a complex, aquifer-specific transport issue, and its description is beyond the scope of this Standard Operating Procedure (SOP). However, concentrations of suspended colloids have been measured during steady state conditions and during purging activities. Investigation results indicate standard purging procedures can cause a significant increase in colloid concentrations, which in turn may bias analytical results.

Micropurge sample collection provides a method of minimizing increased colloid mobilization by removing water from the well at the screened interval at a rate that preserves or minimally disrupts steady-state flow conditions in the aquifer. During micropurge sampling, groundwater is discharged from the aquifer at a rate that the aquifer will yield without creating a cone of depression around the sampled well. Research indicates that colloid mobilization will not increase above steady-state conditions during low-flow discharge. Therefore, the collected sample is more likely to represent steady-state groundwater chemistry.

1.1 PURPOSE

The purpose of this SOP is to describe the procedures to be used to collect a groundwater sample from a well using the micropurge technology. The following sections describe the equipment to be used and the methods to be followed to promote uniform sample collection techniques by field personnel that are experienced in sample collection and handling for environmental investigations.

1.2 SCOPE

This SOP applies to groundwater sampling using the micropurge technology. It is intended to be used as an alternate SOP to the general "Groundwater Sampling" SOP (SOP No. 10) that provides guidance for the general aspects of groundwater sampling.

1.3 DEFINITIONS

Colloid: Suspended particles that range in diameter from 5 nanometers to 0.2 micrometers.

Dissolved oxygen: The ratio of the concentration or mass of oxygen in water relative to the partial pressure of gaseous oxygen above the liquid which is a function of temperature, pressure, and concentration of other solutes.

Flow-through cell: A device connected to the discharge line of a groundwater purge pump that allows regular or continuous measurement of selected parameters of the water and minimizes contact between the water and air.

pH: The negative base-10 log of the hydrogen-ion activity in moles per liter.

Reduction and oxidation potential: A numerical index of the intensity of oxidizing or reducing conditions within a system, with the hydrogen-electrode potential serving as a reference point of zero volts.

Specific conductance: The reciprocal of the resistance in ohms measured between opposite faces of a centimeter cube of aqueous solution at a specified temperature.

Turbidity: A measurement of the suspended particles in a liquid that have the ability to reflect or refract part of the visible portion of the light spectrum.

1.4 REFERENCES

Puls, R. W. and M. J. Barcelona. 1996. Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. U.S. Environmental Protection Agency. Office of Research and Development. EPA/540/S-95/504. April.

1.5 REQUIREMENTS AND RESOURCES

The following equipment is required to complete micropurge sample collection :

- Water level indicator
- Adjustable flow rate pump (bladder, piston, peristaltic, or impeller)
- Discharge flow controller
- Flow-through cell
- pH probe
- Dissolved oxygen (DO) probe
- Turbidity meter
- Oxidation and reduction (Redox or Eh) probe
- Specific conductance (SC) probe (optional)
- Temperature probe (optional)
- Meter to display data for the probes
- Calibration solutions for pH, SC, turbidity, and DO probes, as necessary
- Container of known volume for flow measurement or calibrated flow meter
- Data recording and management system

2.0 PROCEDURE

The following procedures and criteria were modified from the U. S. Environmental Protection Agency guidance titled "Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures" (Puls and Barcelona 1996). This reference may be consulted for a more detailed description of micropurge sampling theory.

Micropurging is most commonly accomplished with low-discharge rate pumps, such as bladder pumps, piston pumps, controlled velocity impeller pumps, or peristaltic pumps. Bailers and high capacity submersible pumps are not considered acceptable micropurge sample collection devices. The purged water is monitored (in a flow-through cell or other constituent monitoring device) for chemical and optical parameters that indicate steady state flow conditions between the sample extraction point and the aquifer. Samples are collected when steady state conditions are indicated.

Groundwater discharge equipment may be permanently installed in the monitoring well as a dedicated system, or it can be installed in each well as needed. Most investigators agree that dedicated systems will provide the best opportunity for collecting samples most representative of steady state aquifer conditions, but the scope of a particular investigation and available investigation funds will dictate equipment selection.

2.1 EQUIPMENT CALIBRATION

Prior to sample collection, the monitoring equipment used to measure pH, Eh, DO, turbidity, and SC should be calibrated or checked according to manufacturer's directions. Typically, calibration activities are completed at the field office at the beginning of sampling activities each day. The pH meter calibration should bracket the pH range of the wells to be sampled (acidic to neutral pH range [4.00 to 7.00] or neutral to basic pH range [7.00 to 10.00]). The DO meter should be calibrated to one point (air-saturated water) or two points (air-saturated water and water devoid of all oxygen). The SC meter cannot be calibrated in the field. It is checked against a known standard (typical standards are 1, 10, and 50 millimhos per centimeter at 25EC). The offset of the measured value of the calibration standard can be used as a correction value. Similarly, the Eh probe cannot be calibrated in the field, but is checked against a known standard, such as Zobell solution. The instrument should display a millivolt (mv) value that falls within the range set by the manufacturer. Because Eh is temperature dependent, the measured value should be corrected for site-specific variance from standard temperature (25EC). The Eh probe should be replaced if the reading is not within the manufacturer's specified range. All calibration data should be recorded on the Micropurging Groundwater Sampling Data Sheet attached to this SOP or in a logbook.

2.2 WELL PURGING

The well to be sampled should be opened and groundwater in the well allowed to equilibrate to atmospheric pressure. Equilibration should be determined by measuring depth to water below the marked reference on the wellhead (typically the top of the well casing) over two or more 5-minute intervals. Equilibrium conditions exist when the measured depth to water varies by less than 0.01 foot over two consecutive readings. Total depth of well measurement should be made following sample collection, unless the datum is required to place nondedicated sample collection equipment. Depth to water and total well depth measurements should be made in accordance with procedures outlined in SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement).

If the well does not have a dedicated sample collection device, a new or previously decontaminated portable sample collection device should be placed within the well. The intake of the device should be positioned at the midpoint of the well screen interval. The device should be installed slowly to minimize turbulence within the water in the casing and mixing of stagnant water above the screened interval with water in the screened interval. Following installation, the flow controller should be connected to the sample collection device and the flow-through cell connected to the outlet of the sample collection device. The calibrated groundwater chemistry monitoring probes should be installed in the flow-through cell. If a flow meter is used, it should be installed ahead of the flow-through cell.

If the well has a dedicated sample collection device, the controller for the sample collection device should be connected to the sample collection device. The flow meter and flow-through cell should be connected in line to the discharge tube, and the probes installed in the flow-through cell.

The controller should be activated and groundwater extracted (purged) from the well. The purge rate should be monitored, and should not exceed the capacity of the well. The well capacity is defined as the maximum discharge rate that can be obtained with less than 0.1 meter (0.3 foot) drawdown. Typically, the discharge rate will be less than 0.5 liters per minute (L/min) (0.13 gallons per minute). The maximum purge rate should not exceed 1 L/min (0.25 gallons per minute), and should be adjusted to achieve minimal drawdown.

Water levels, effluent chemistry, and effluent flow rate should be continuously monitored while purging the well. Purging should continue until the measured chemical and optical parameters are stable. Stable parameters are defined as monitored chemistry values that do not fluctuate by more than the following ranges over three successive readings at 3-minute intervals: ±0.1 pH unit; ±3 percent for SC; ±10 mv for Eh; and ±10 percent for turbidity and DO. Purging will continue until these stabilization criteria have been met or three well casing volumes have been purged. If three casing volumes of water have been purged and the stabilization criteria have not been met, a comment should be made on the data sheet that sample collection began after three well casing volumes were purged. The final pH, SC, Eh, turbidity, and DO values will be recorded. All data should be recorded on the Micropurging Groundwater Sampling Data Sheet attached to this SOP or in a logbook.

2.3 SAMPLE COLLECTION

Following purging, the flow through cell shall be disconnected, and groundwater samples collected directly from the discharge line. Discharge rates should be adjusted so that groundwater is dispensed into the sample container with minimal aeration of the sample. Samples collected for volatile organic compound analysis should be dispensed into the sample container at a flow rate equal to or less than 100 milliliters per minute. Samples should be preserved and handled as described in the investigation field sampling plan or quality assurance project plan.

Tetra Tech EM Inc.

MICROPURGING GROUNDWATER SAMPLING DATA SHEET

Page _____ of _____

Date ____________

Well Name ____________________
Project ____________________
Project No. ____________________
Well Location ____________________
Sample Date ____________________
Sampling Personnel ____________________
____
____
Sample ID ____________________
Duplicate ID ____________________

Screen Interval ____________________
Station Elevation ________ GND ____ TOC ______
Static Water Level (from TOC) ____________
Well Stick Up ____________________
Static Elevation ____________________
Well Depth __________ MEAS ____ RPTD ______
Feet of Water ____________________
Gallons/Foot ____________________
Casing Volume ____________________

Immiscible Phases Present ☐ Yes ☐ No
Type ____________________
Measured with ____________________
PID Readings (background) ____________
PID Reading (TOC) ____________________
Wells Installed by ____________________
Installation Date ____________________
Development Date(s) ____________________

FIELD CHEMISTRY CALIBRATIONS

Date/Time ____________________ Spec. Conductance: Standard ________ µmhos/cm at 25EC Reading ________ µmhos/cm at _____EC
pH: pH 4.00 - _______ at _________EC pH 7.00 - _______ at _________EC pH 10.00 - ______ at _______EC Slope ______________
Dissolved Oxygen: D.O. Meter _______ mg/L at _______EC PID: Calibration Gas __________ PPM ______ Span ______ Reading __________

PURGING

Time	Discharge Rate (mL/min)	Dissolved Oxygen (mg/L)	pH	Eh/ORP (mV)	Temp. (EC)	Specific Conduct. (µmhos/cm at EC)	Turbidity (NTU)	Cumulative Volume of Water Removed (Purged): Gallons	Cumulative Volume of Water Removed (Purged): Casing Vol.	PID/OVA Reading: Location	PID/OVA Reading: Value	Depth to Water (ft)	Comments

SAMPLE PARAMETERS

Condition of well: ____________________

Remarks: ____________________

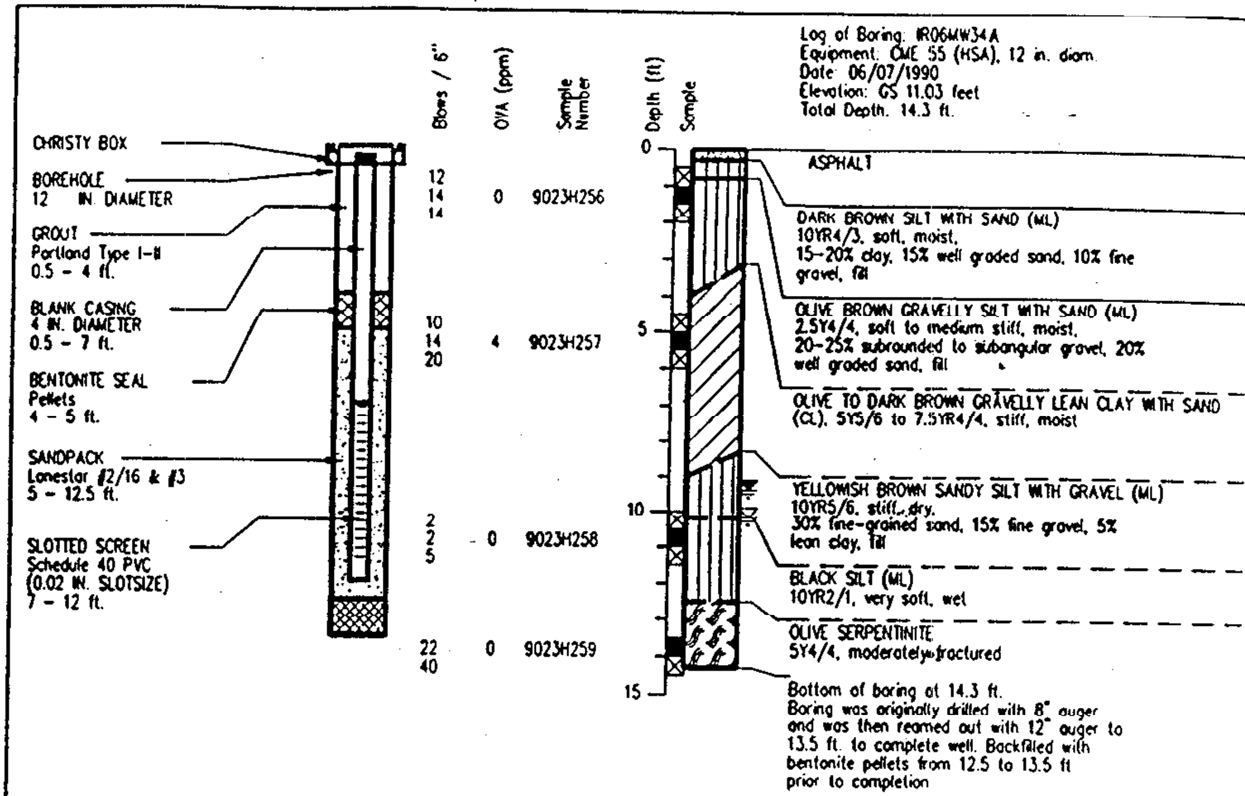
FIELD EQUIPMENT

pH Meter ____________________ Serial Number ____________________
Spec. Cond. Meter ____________________ Serial Number ____________________
Pump ____________________ Serial Number ____________________
Water Level Meter ____________________ Serial Number ____________________
D.O. Meter ____________________ Serial Number ____________________
Filter Apparatus ____________________ Filters ____________________
Temperature Measure ____________________
Interface Probe ____________________ Serial Number ____________________
PID/OVA ____________________ Serial Number ____________________

Field Chemistry Calibrations

Fractions ____________________
____
____
Number of Bottles ____________________
Sample Depth ____________________
Field Notebook ____________________
Sample Method ____________________
____
Discharge Water Containerized ☐ Yes ☐ No

APPENDIX D
WELL CONSTRUCTION LOGS



Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion Detail: IR06MW34A
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE **D144**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
PCB	02176,266.02	BPF	5/92	

Log of Boring IR06MW40A
Equipment: CME-55 (HSA), 12 in. diam.
Date: 06/06/1990
Elevation: GS 10.66 feet
Total Depth: 31 ft.

CHRISTY BOX

BOREHOLE
12 IN. DIAMETER

GROUT
Portland Type I-II
1 - 4 ft.

BLANK CASING
4 IN. DIAMETER
0.50 - 7 ft.

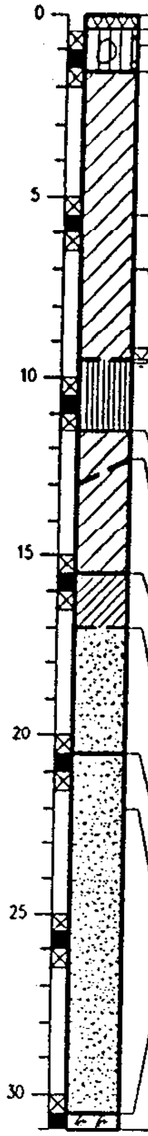
BENTONITE SEAL
Pellets
4 - 5 ft.

SANDPACK
RMC Lonestar #3
5 - 20.5 ft.

SLOTTED SCREEN
Schedule 40 PVC
(0.02 IN. SLOTSIZE)
7 - 20.5 ft.

Blows / 6"	OVA (ppm)	Sample Number
20 16 12	0	9023G277
3 5 6	0	9023G278
2 4 6	0	9023G279
2 2 4	0	9023G280
16 28 40	0	9023G281
16 12 46	0	9023G282
20 60		9023G283

Depth (ft) — Sample



ASPHALT

DARK REDDISH BROWN SILTY GRAVEL WITH SAND (GM)
5YR3/2, loose, moist,
55-65% angular fine to coarse gravel, 15-20% sand, 15% silt, fill

Color change to strong brown (7.5YR4/6) at 0.9 ft.

OLIVE GRAY LEAN CLAY WITH SAND (CL)
5Y4/2, medium stiff, moist,
60-70% clay, 15-20% silt, 15-20% sand, fill

Color change to greenish gray (5G5/1), soft at 5.5 ft.

Color change to olive gray (5Y4/2) at 7 ft.

VERY DARK GRAY ELASTIC SILT (MH)
5Y3/1, very soft, wet,
80-90% silt, 5-10% clay, 5% plant debris, fill

OLIVE SANDY LEAN CLAY (CL)
5Y4/3, medium stiff, moist,
50-55% clay, 30-35% very fine- to fine-grained sand, 10-15% silt, fill

VERY DARK GRAY LEAN CLAY (CL)
5Y3/1, soft, moist,
55-60% clay, 20-25% silt, 5-10% sand, fill

DARK GREENISH GRAY FAT CLAY (CH)
5BG4/1, soft, moist,
0.1 to 0.2 inch wet sand lenses throughout, trace shell fragments

GREENISH GRAY POORLY GRADED SAND (SP)
5G5/1, very loose, wet,
80-85% very fine- to medium-grained sand, few shell fragments, trace silt and fine rounded gravel

YELLOWISH BROWN POORLY GRADED SAND (SP)
10YR5/8, dense, moist to wet,
90-95% very fine- to fine-grained sand, trace silt

Color change to olive (5Y4/3) wet at 22 ft.

PALE OLIVE SERPENTINITE
5Y6/4, moderately hard, dry,
moderately fractured, little weathering

Bottom of boring at 31 ft.
8" borehole collapsed from 23 to 30 feet.
Boring backfilled with bentonite pellets from 20.5 to 23 feet.

Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion Detail: IR06MW40A
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE D146

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RWS	02176,266.02	BPI	6/92	

Log of Boring: IR06MW41A
Equipment: CME 55 (HSA) 12.00 in. diam.
Elevation: GS 10.38
Date: 06/05/1990
Total Depth: 21.00 ft.

CHRISTY BOX

BOREHOLE
12.00 IN. DIAMETER

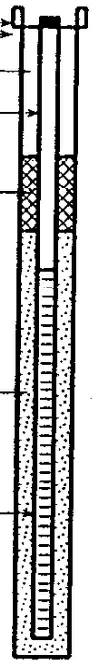
GROUT
Portland Type I-II
1.00 - 4.00 ft.

BLANK CASING
4.00 IN. DIAMETER
0.50 - 7.00 ft.

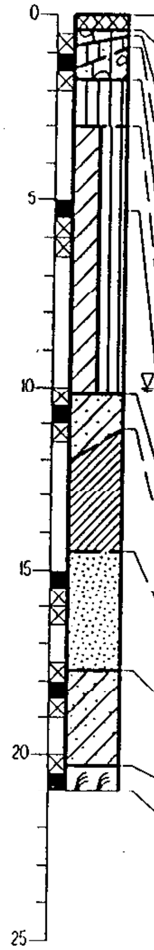
BENTONITE SEAL
Pellets
4.00 - 6.00 ft.

SANDPACK
Lonestar #3
6.00 - 17.50 ft.

SLOTTED SCREEN
Schedule 40 PVC
(0.02 IN. SLOTSIZE)
7.00 - 17.00 ft.



Blows/6"	OVA (ppm)	Sample Number
20 33 15	0	9023H246
4 9 8	0	9023H247
3 4 3	0	9023H248
2 2 2	200	9023H249
9 12 20	0	9023H250
17 50	1	9023H251



ASPHALT

DARK BROWN SILTY GRAVEL WITH SAND (GM)
10YR3/3, very loose, moist,
30% silt, approximately 10% well graded sand, fill

YELLOWISH BROWN SILTY SAND WITH GRAVEL (SM)
10YR5/4, very loose, moist to wet,
well graded sand, 30% silt, 15% angular gravel, fill

BROWN SILTY GRAVEL WITH SAND (GM)
10YR5/3, very loose, dry,
coarse angular gravel, 30% silt, 15% well graded sand, fill

OLIVE GRAY GRAVELLY SILT WITH SAND (ML)
5Y5/3, soft, moist,
mostly weathered serpentinite, 20% well graded gravel, 10% clay, 10% sand, fill

VERY DARK GRAYISH BROWN SILTY LEAN CLAY WITH SAND
(CL/ML), 2.5Y3/2, medium stiff, moist to dry,
30% silt, 15% sand, 10% subangular gravel

Color change to dark greenish gray at 5.3 ft.

DARK YELLOWISH BROWN POORLY GRADED SAND WITH CLAY
(SP-SC), 10YR4/6, loose, wet,
medium-grained sand, 10% lean clay, fill

DARK BROWN SANDY FAT CLAY (CH)
10YR2/3, soft, moist,
30% silt, 25% medium-grained sand

VERY DARK GRAY POORLY GRADED SAND (SP)
2.5YR3/0, very loose, wet,
fine to medium-grained sand, 15% shell fragments, 10% silt

YELLOWISH BROWN CLAYEY SAND (SC)
10YR5/6, dense, dry,
fine to medium-grained sand, 20% lean clay, less than 10% gravel

MASSIVE SERPENTINITE

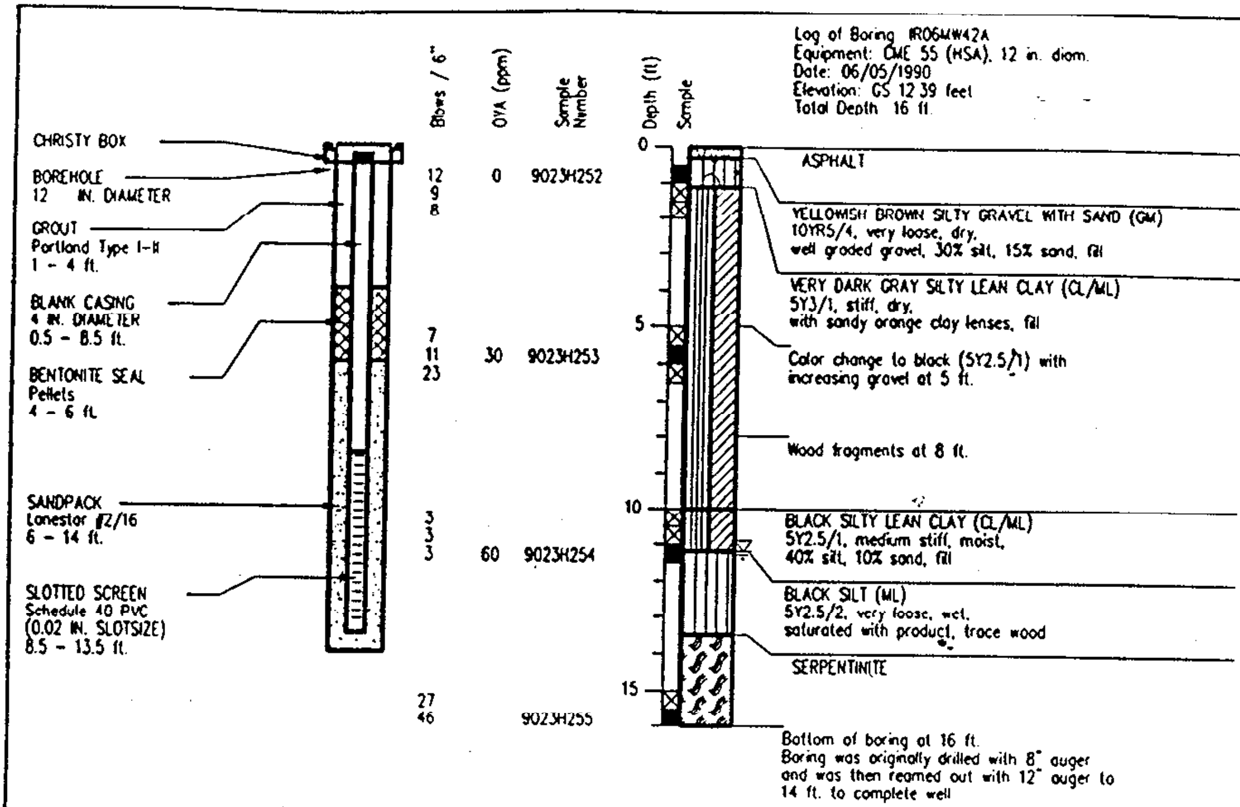
Bottom of boring at 21 ft.
Boring backfilled from 17.5 to 21 feet with bentonite pellets.

Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR06MW41A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
GDT			04/95	



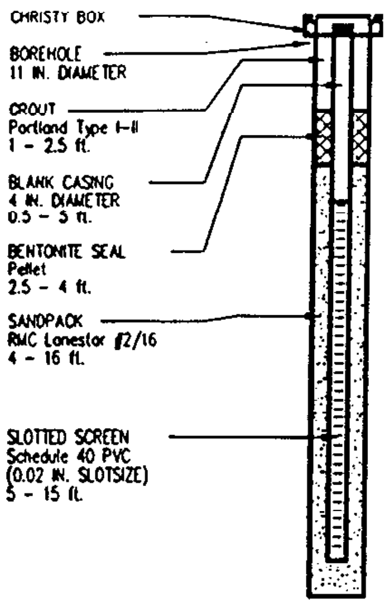
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion Detail: IR06MW42A
OU II RI Report
Hunters Point Annex
San Francisco, California

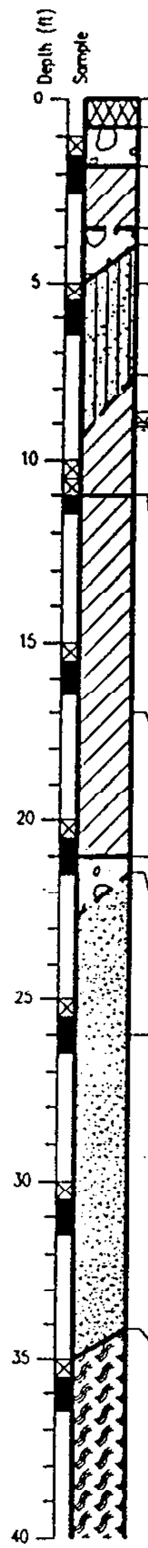
PLATE **D148**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
PCB	02176,266.02	BPF	5/92	

Log of Boring IR06MW44A
Equipment: MOBILE B-53 (HSA), 11 in. diam
Date: 09/19/1991
Elevation: CS 10.27 feet
Total Depth: 41.0 ft.



Blows / 6"	OVA (ppm)	Sample Number
5 22 15	0	9138M192
5 9 11	0	9138M193
3 3 4	0	9138M194
4 6 8	0	9138M195
2 5 20	0	9138M196
25 25 25	0	9138M197
4 13 21	0	9138M198
6 12 32	0	9138M199



ASPHALT

DARK GRAY WELL-GRADED GRAVEL WITH SAND (GW)
10YR4/4, medium dense, moist,
70% subrounded gravel, 25% medium- to fine-grained sand, 5% silt, fill

VERY DARK GRAY SANDY LEAN CLAY WITH GRAVEL (CL)
5Y3/1, medium stiff, moist,
50% clay, 25% medium- to fine-grained sand, 25% subangular serpentinite and sandstone gravel, fill

DARK OLIVE GRAY SERPENTINITE BOULDER FILL
closely fractured, medium hard, weak, deeply weathered, fill

DARK BROWN SILTY SAND (SM)
7.5YR4/4, medium dense, moist,
70% fine-grained sand, 30% silt, trace gravel, fill

Lenses of well-graded gravel with sand at 5 ft.

DARK YELLOWISH BROWN SANDY LEAN CLAY WITH GRAVEL (CL)
10YR4/6, medium stiff, wet,
60% clay, 25% fine-grained sand,
15% subangular gravel, fill

Wet at 9 ft.

DARK OLIVE GRAY SANDY LEAN CLAY (CL)
5Y3/2, medium stiff, wet,
60% clay, 40% medium- to fine-grained sand, trace gravel, fill

Gravel lens at 17 ft.

DARK GREENISH GRAY SERPENTINITE BOULDER FILL
5GY4/1,
intensely fractured, medium strong, moderately hard to friable, deeply weathered, fill

DARK GRAY POORLY GRADED SAND (SP)
5Y4/1, medium dense, wet,
95% medium- to fine-grained sand, 5% silt

Color change to dark yellowish brown (10YR4/6) at 26 ft.

DARK OLIVE GRAY SERPENTINITE BEDROCK
5Y3/2,
intensely fractured, low hardness, weak, deeply weathered

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Engineering and Environmental Services

Log of Boring and Well Completion Detail: IR06MW44A
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE
D149a

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RWS	02176,266.02	BPF	6/92	

Log of Boring: IR06MW44A (p. 2)
Equipment: MOBILE B-53 (HSA), 11.0 in. diam.
Date: 09/19/1991
Elevation: GS 10.27 feet
Total Depth: 41.0 ft.

Blows / 6"	OVA (ppm)	Sample Number	Depth (ft)	Sample
16 50			40	

Bottom of boring at 41 feet. Boring backfilled with bentonite chips from 41 to 16 feet (9/19/91)

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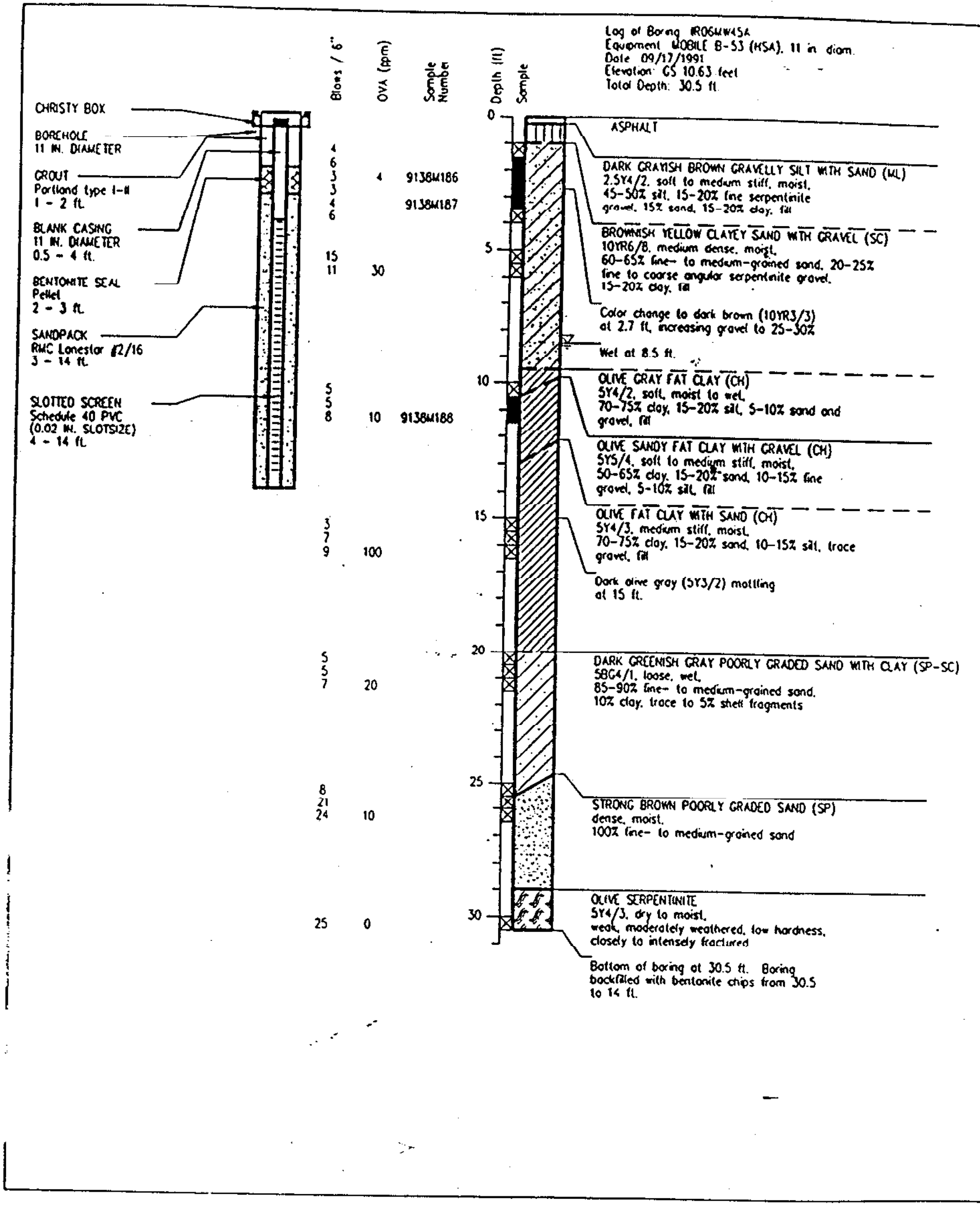
Engineering and Environmental Services

Log of Boring and Well Completion Detail: IR06MW44A
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE
D 149b

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RWS	02176.266 02	BDF	6/92	

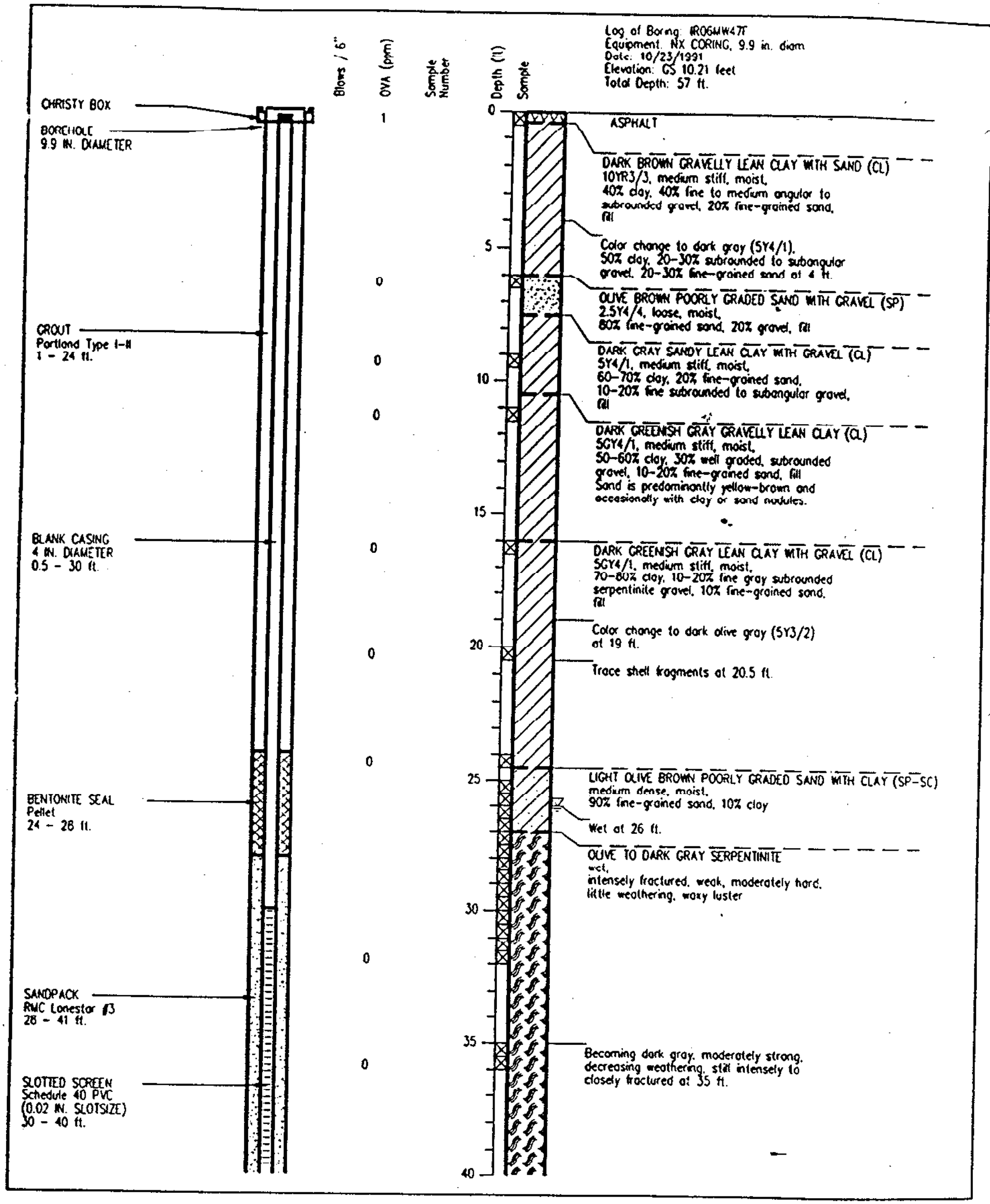


Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion Detail: IR06MW45A
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE **D150**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
PCB	02176.266.02	BPF	5/92	



Harding Lawson Associates
Engineering and Environmental Services

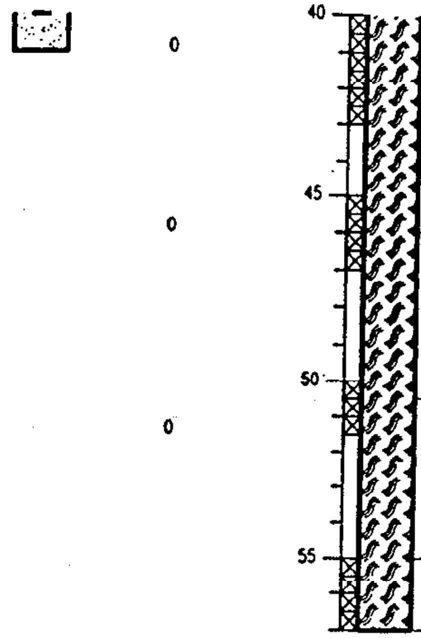
Log of Boring and Well Completion Detail: IR06MW47F
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE **D152a**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
PCB	02176,266.02	BPF	5/92	

Log of Boring: IR06MW47F (p. 2)
Equipment: NX CORING, 9.9 in. diam.
Date: 10/23/1991
Elevation: GS 10.21 feet
Total Depth: 57.0 ft.

Blows / 6"	OVA (ppm)	Sample Number	Depth (ft)	Sample	Description
	0		40		Color change to dark blue gray (5B4/1), weak to moderately strong, abundant talc, friable, very low hardness at 40 ft.
	0		45		Deeply weathered, abundant talc, possible shear zone? at 46 ft.
	0		50		Weak, moderately hard, intensely fractured, little weathering at 50.5 ft.
			55		Color change to dark greenish gray, hard, moderately strong to strong, fresh, closely fractured, fractures mineralized at 55 ft.
					Bottom of boring at 57 ft.



Harding Lawson Associates
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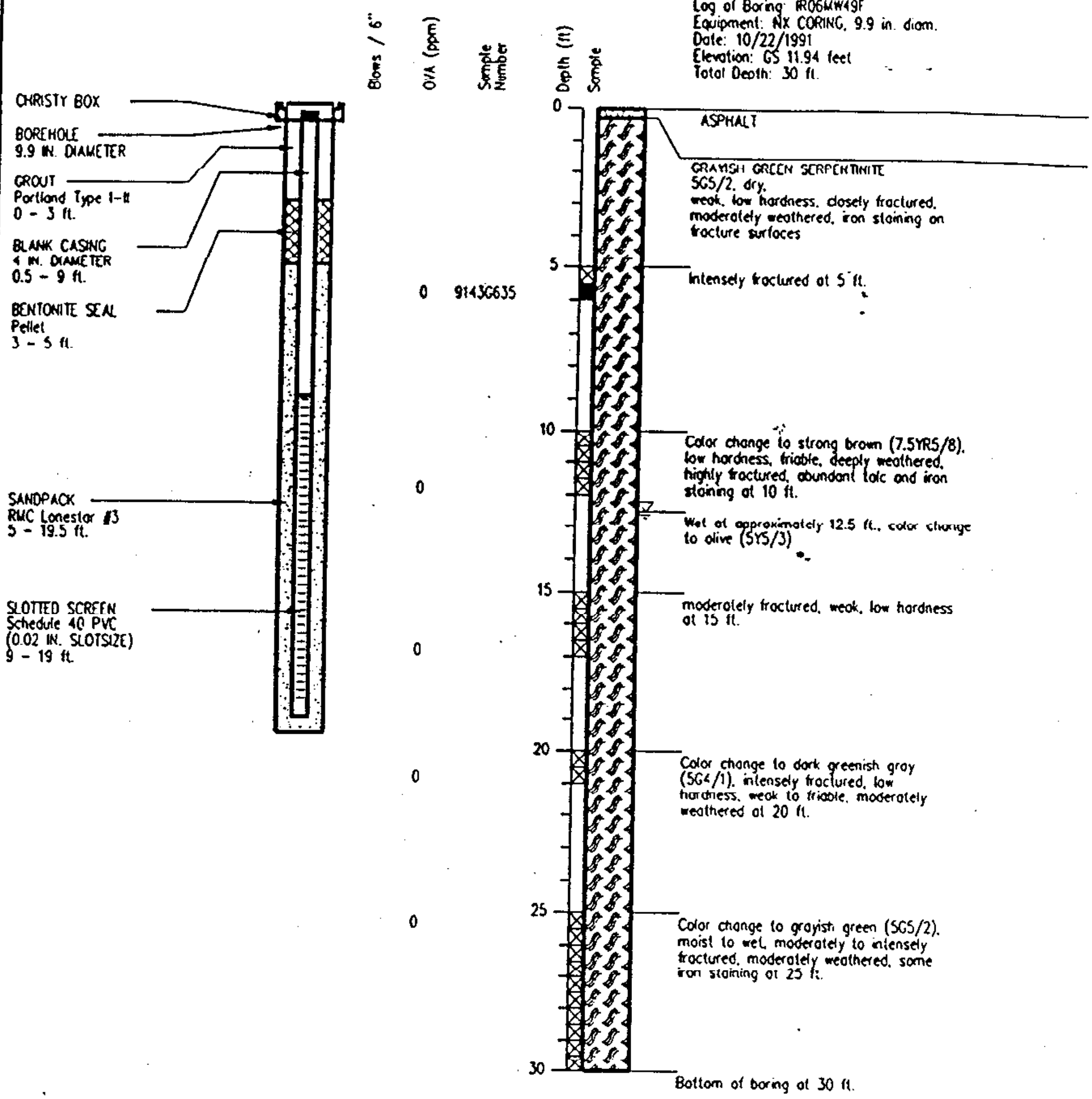
Log of Boring and Well Completion Detail: IR06MW47F
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE
D152b

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
PCB	02176,266.02	BPF	5/92	

Log of Boring: IR06MW49F
Equipment: NX CORING, 9.9 in. diam.
Date: 10/22/1991
Elevation: GS 11.94 feet
Total Depth: 30 ft.



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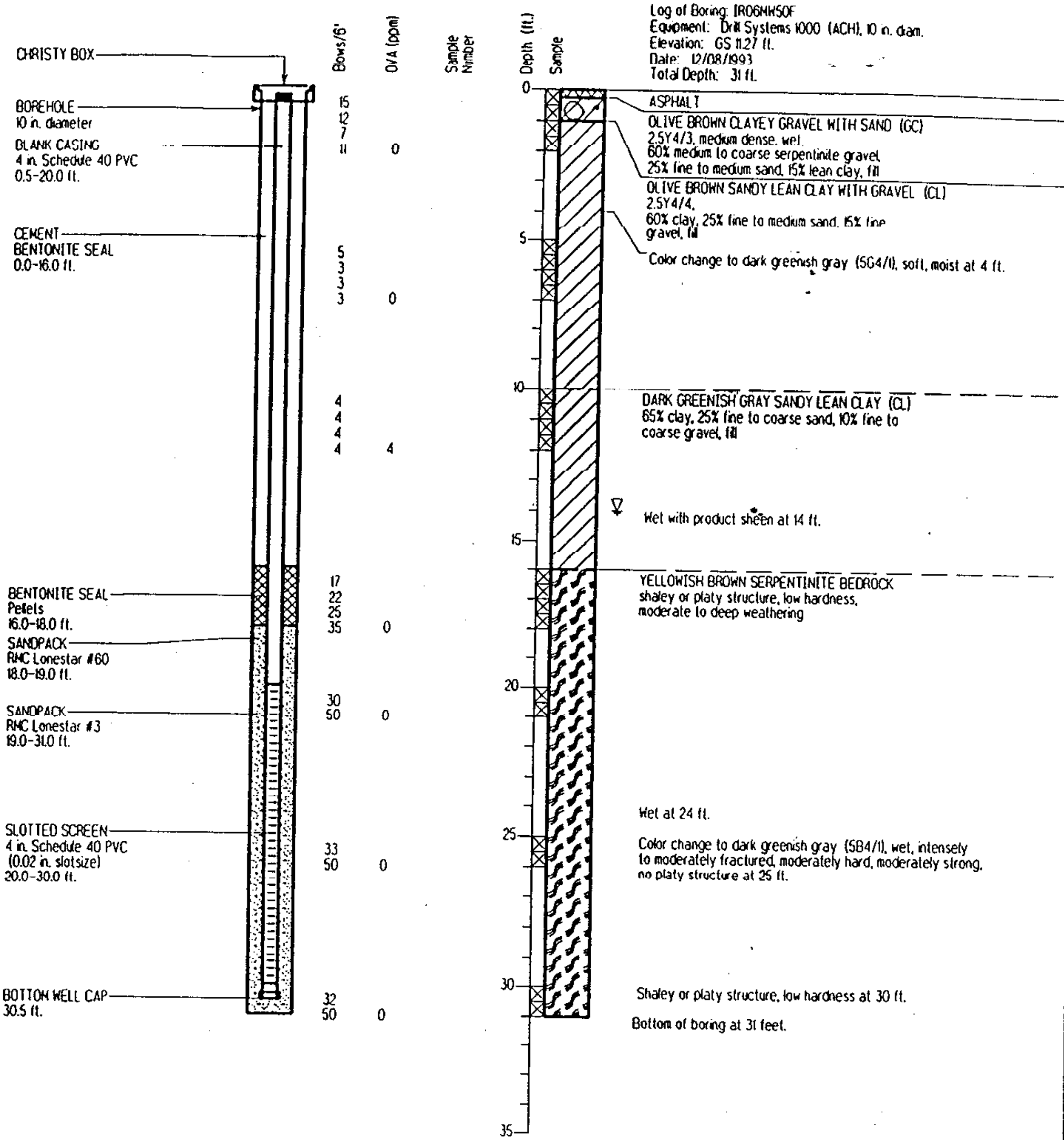
Engineering and Environmental Services

Log of Boring and Well Completion Detail: IR06MW49F
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE **D154**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
PCB	02176,266.02	BPF	5/92	

Log of Boring: IR06MW50F
Equipment: Drill Systems 1000 (ACH), 10 in. diam.
Elevation: GS 11.27 ft.
Date: 12/08/1993
Total Depth: 31 ft.



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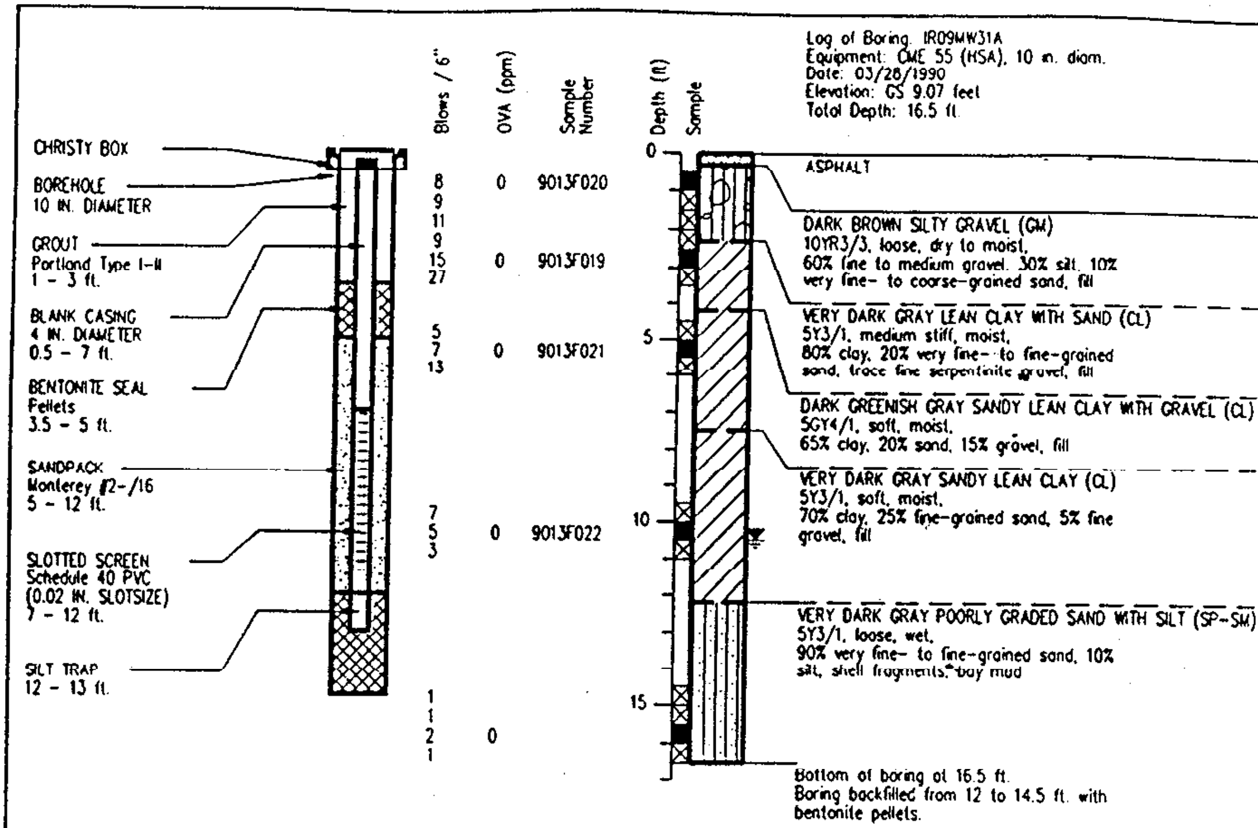
Environmental Services

Log of Boring and Well Completion IR06MW50F
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 1402		07/94	

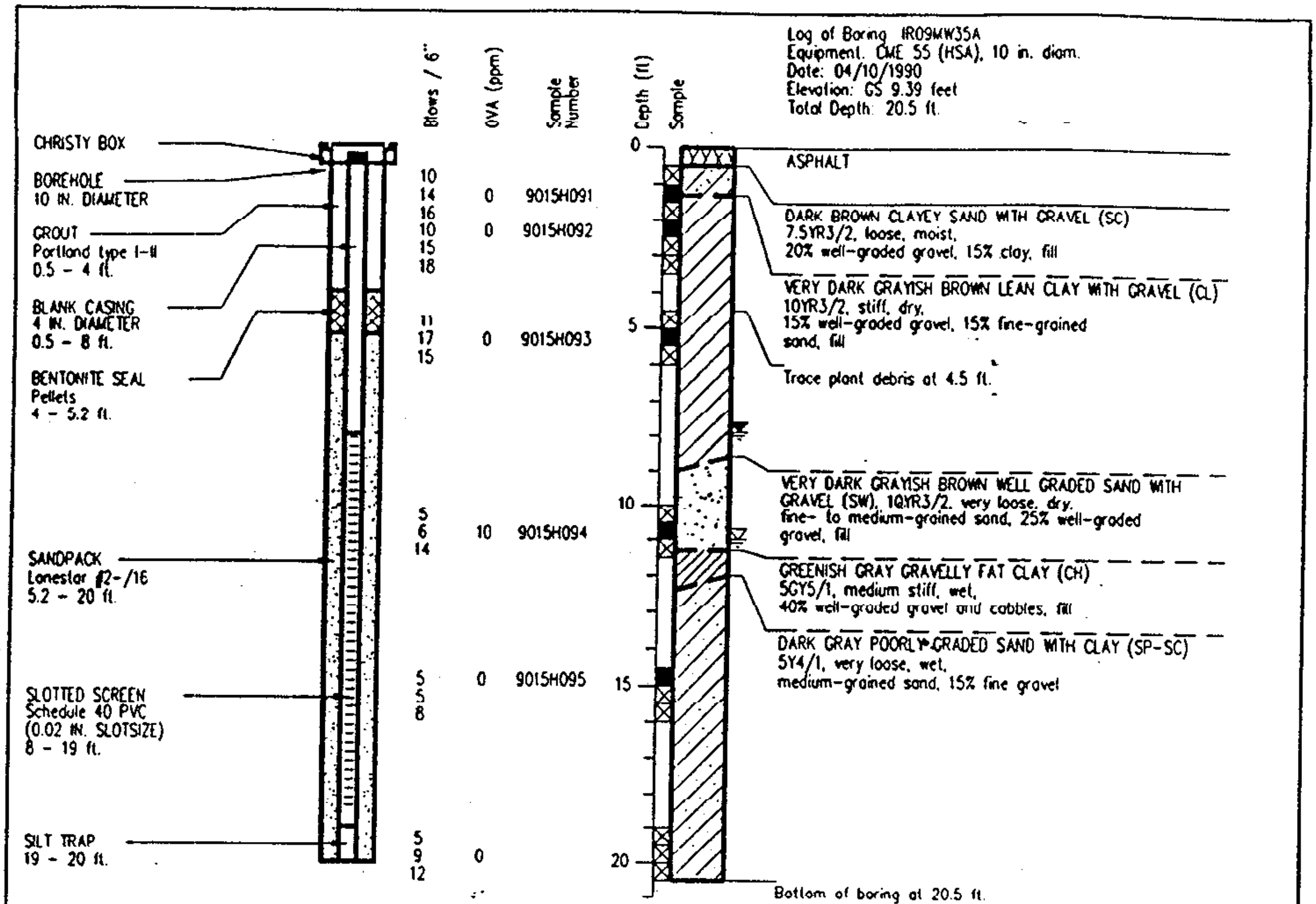


Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion Detail: IR09MW31A
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE
D92

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
PCB	02176.266.02	BPF	5/92	



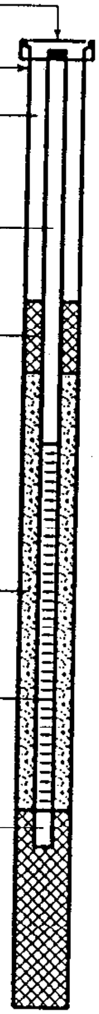
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion Detail: IR09MW35A
OU II RI Report
Hunters Point Annex
San Francisco, California

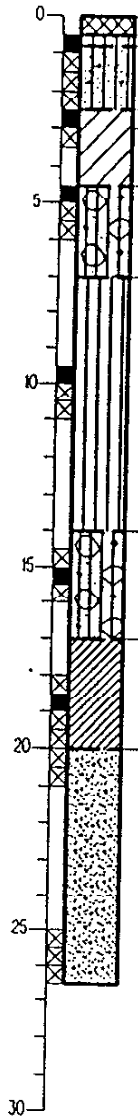
PLATE **D93**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
PCB	02176,266.02	OPF	5/92	

Log of Boring: IR09MW36A
Equipment: CME 55 (HSA), 10 in. diam.
Elevation: GS 9.39 feet
Date: 04/09/1990
Total Depth: 20.5 ft.



Blows/6"	OVA (ppm)	Sample Number
33, 23, 13	0	9015G170
10, 18, 22	0	9015G171
8, 10, 15		9015G172
3, 2, 4	0	9015G173
3, 3, 4	0	9015G174
3, 3, 4, 3, 5, 8	0	
3, 3, 3		



ASPHALT

DUSKY RED SANDY SILT (ML)
10YR3/4, medium stiff, dry to moist,
30-40% fine- to very coarse-grained sand,
40-50% silt, trace gravel and clay, fill

YELLOWISH BROWN SILTY SAND WITH GRAVEL (SM)
10YR5/8, medium dense, moist,
50-60% very fine- to coarse-grained sand,
15-25% silt, 15-20% fine gravel, fill

DARK GRAY SANDY LEAN CLAY WITH GRAVEL (CL)
7.5YR4/0, medium stiff, moist,
50-55% clay, 15-25% silt, 15-20% fine- to coarse-grained sand, 15-20% fine to coarse gravel, fill

Color change to light olive brown (2.5YR5/4) at 3 ft.

OLIVE BROWN SILTY GRAVEL WITH SAND (GM)
2.5Y4/4, medium dense, moist,
40-50% fine to coarse serpentinite gravel,
20-30% fine- to coarse-grained sand, 20-30% silt, fill

DARK GRAY SANDY SILT WITH GRAVEL (ML)
5Y4/1, soft, moist,
55-65% silt, 15-20% fine- to coarse-grained sand, 15-20% fine angular gravel, little to some clay, fill

OLIVE SILTY GRAVEL WITH SAND (GM)
5Y5/3, loose, wet,
40-50% fine angular gravel, 30-40% fine- to coarse-grained sand, 15-20% silt, fill

DARK GREENISH GRAY SANDY FAT CLAY (CH)
5G4/1, soft, moist,
60-70% clay, 25-35% sand, few fine gravels, trace silt, fill
No sample recovery from 19.5 to 21 ft.

POORLY GRADED SAND (SP)
loose, wet,
fine- to medium-grained sand, trace shell fragments

No sample recovery from 25 to 26.5 ft., retrieved trace amount of sediment on sampler

Bottom of boring at 26.5 ft. Boring backfilled from 21 to 26.5 feet with bentonite pellets.

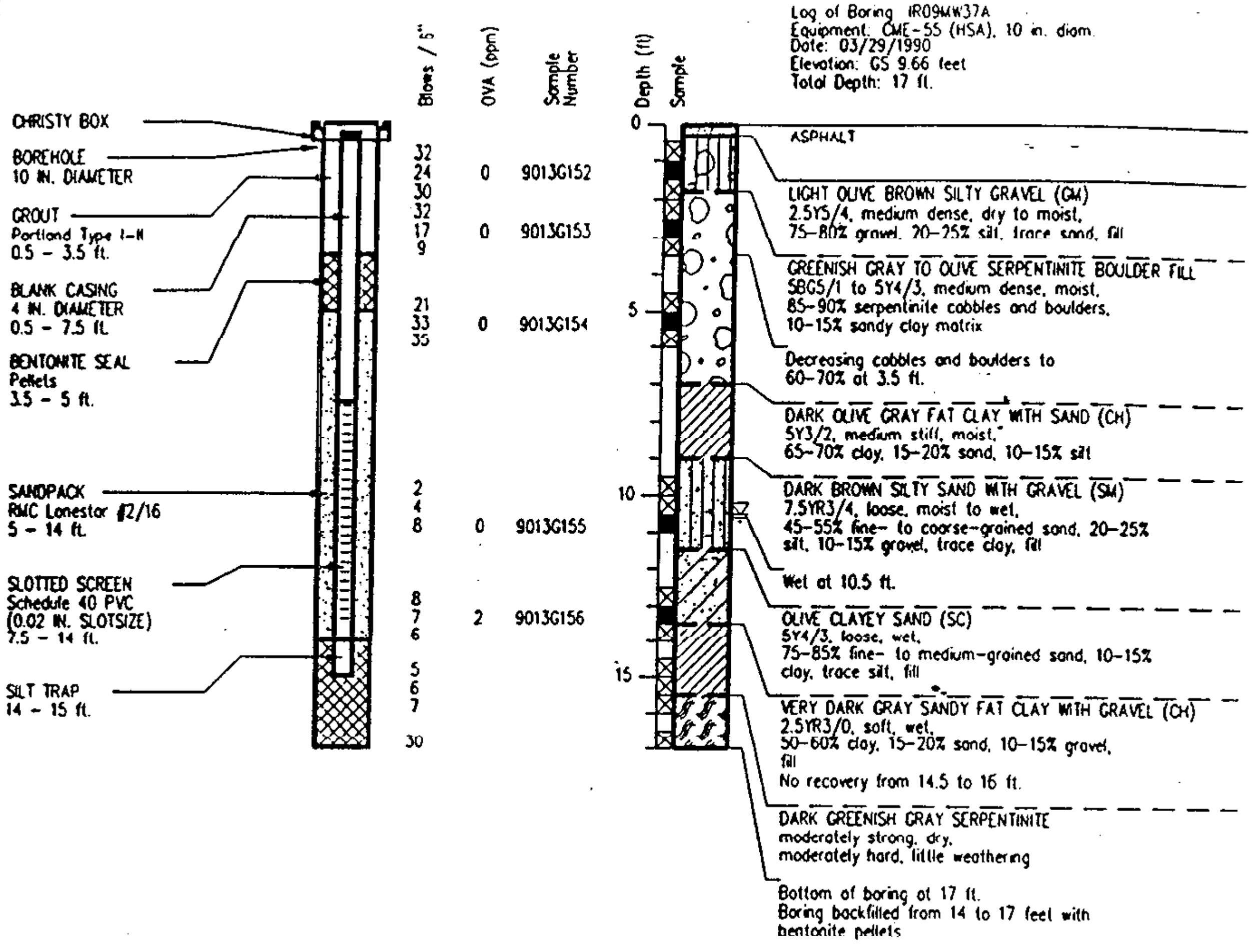
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR09MW36A
OU II RI Report
Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
mf	11400 1005		03/94	

Log of Boring IR09MW37A
Equipment: CME-55 (HSA), 10 in. diam.
Date: 03/29/1990
Elevation: GS 9.66 feet
Total Depth: 17 ft.



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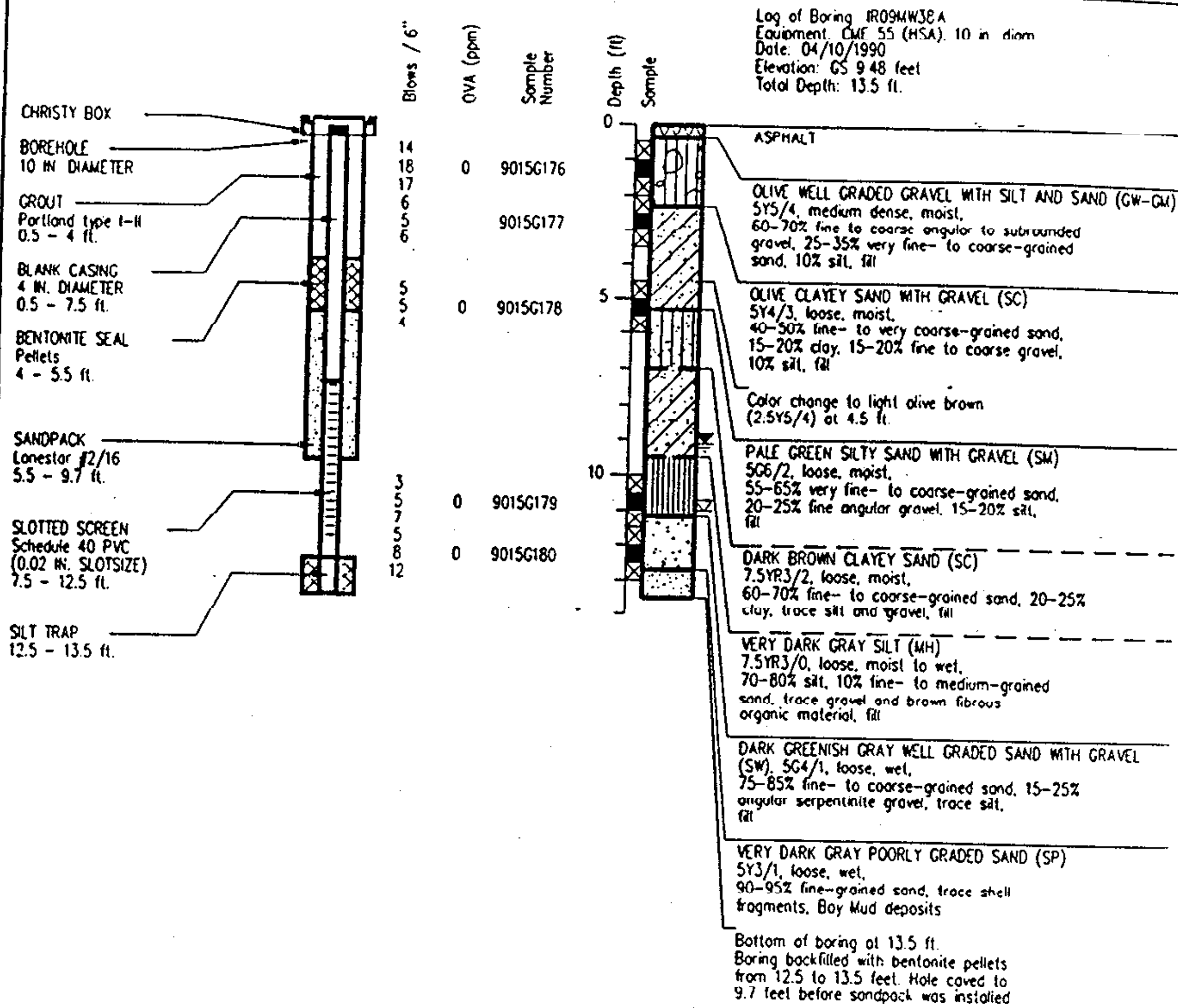
Engineering and Environmental Services

Log of Boring and Well Completion Detail: IR09MW37A
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE
D95

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RWS	02176,266.02	BPF	6/92	



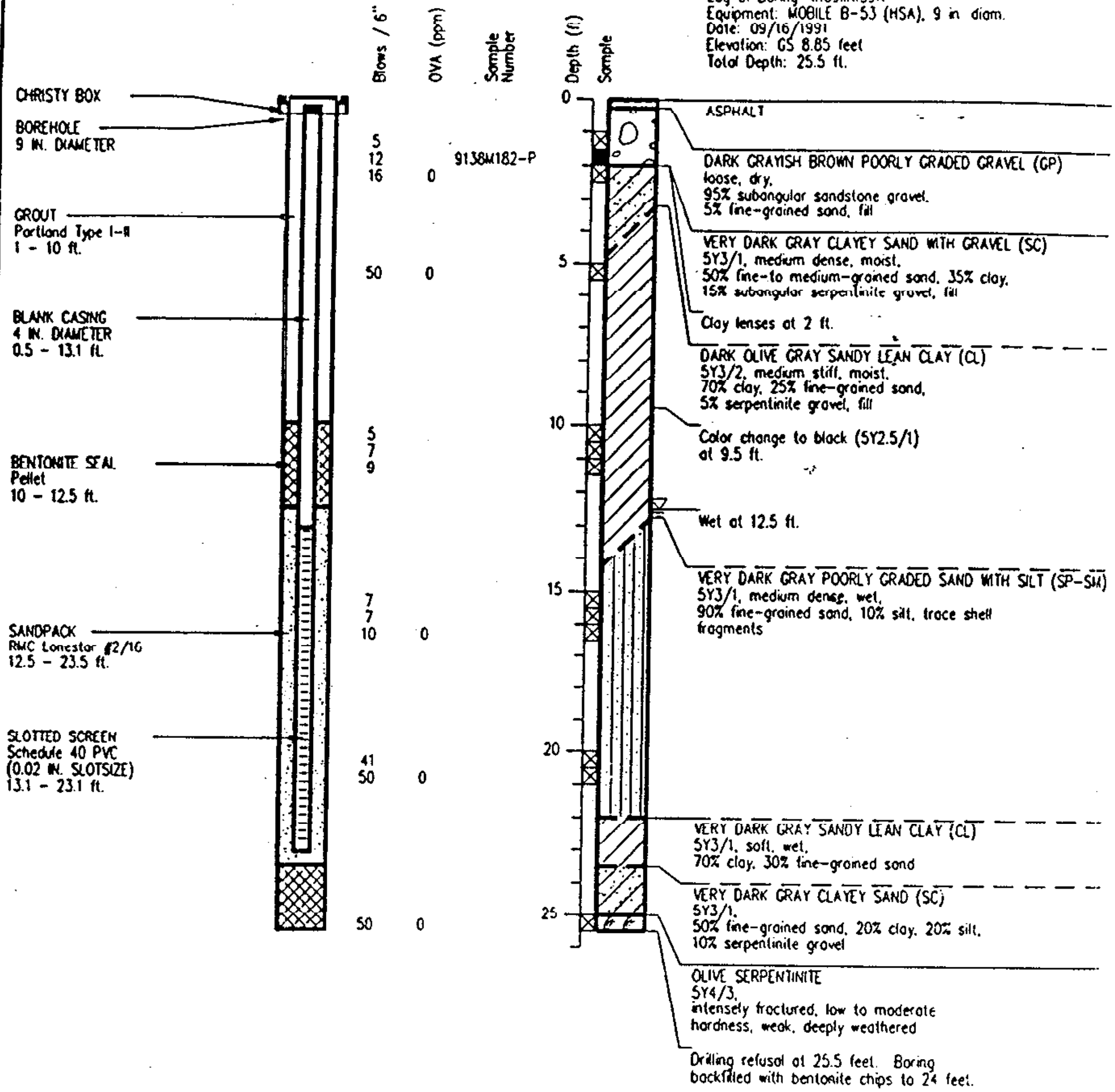
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion Detail: IR09MW38A
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE **D96**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
PCB	02176.266.02	BPF	5/92	

Log of Boring IR09MW39A
Equipment: MOBILE B-53 (HSA), 9 in. diam.
Date: 09/16/1991
Elevation: GS 8.85 feet
Total Depth: 25.5 ft.

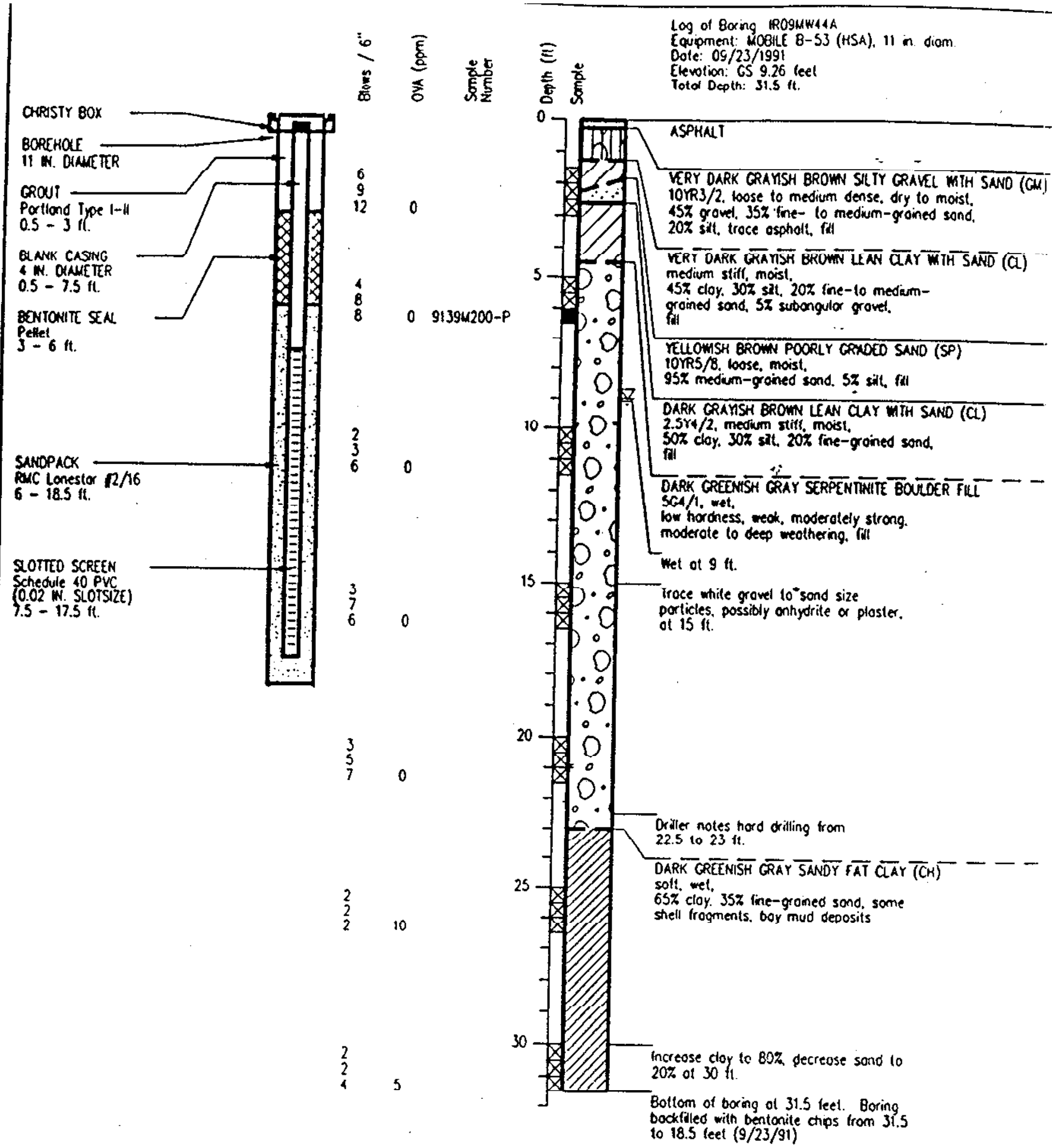


Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion Detail: IR09MW39A
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE
D97

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RWS	02176,266.02	APF	6/92	

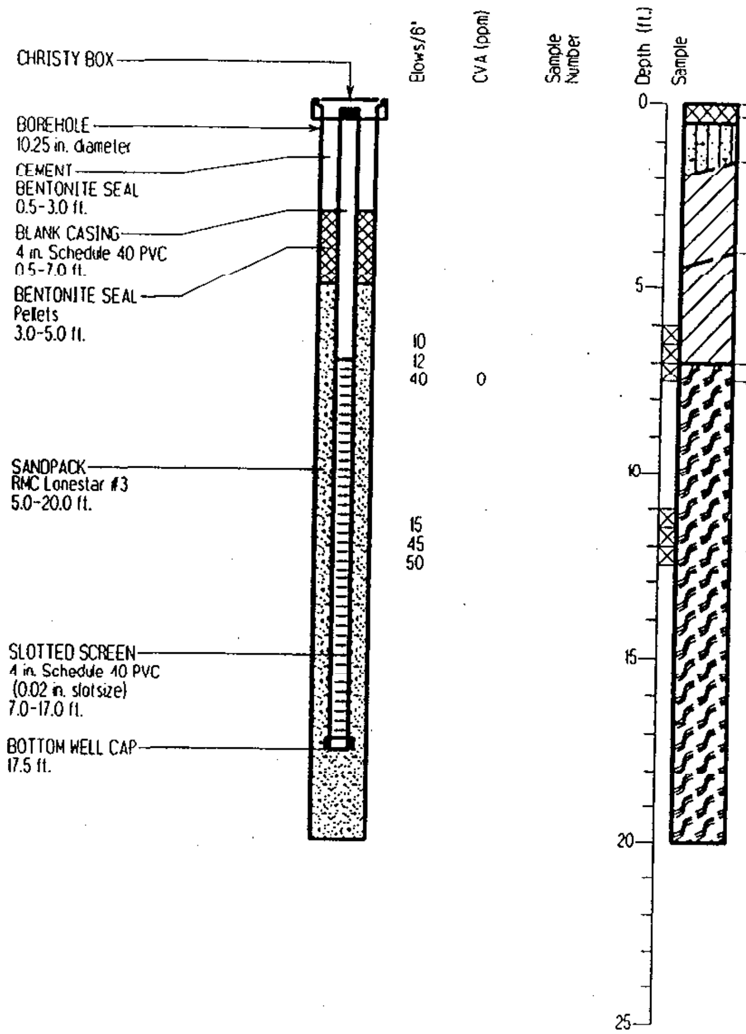


Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion Detail: IR09MW44A
OU II RI Report
Hunters Point Annex
San Francisco, California

PLATE
D98

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
RWS	02176.266.02	BPF	6/92	



Log of Boring: IR09MW45F
Equipment: Speedstar (ARCH), 10 in. diam.
Elevation: GS 8.88 ft.
Date: 7/27/1994
Total Depth: 20 ft.

ASPHALT

VERY DARK GRAY SILTY SAND (SM)
5Y3/1, loose, moist,
60% fine to medium sand, 40% silt, fill

DARK YELLOWISH BROWN SANDY LEAN CLAY WITH GRAVEL (CL)
10YR4/6, firm, moist,
65% clay, 20% fine to medium sand, 15% gravel, fill

BROWN LEAN CLAY (CL)
10YR4/3, firm, moist,
95% clay, 5% fine sand, fill

LIGHT OLIVE BROWN SERPENTINITE (sp)
2.5Y5/4, dry, intensely fractured, low hardness,
friable, moderately to deeply weathered

Color change to very dark gray at 7.5 ft.

Grab groundwater sample 9430A989 collected at 12.5 ft.

Bottom of boring at 20 feet.

Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR09MW45F

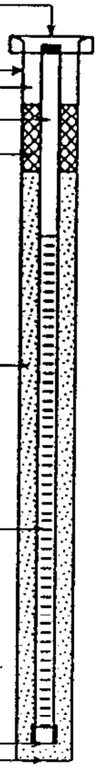
PLATE

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

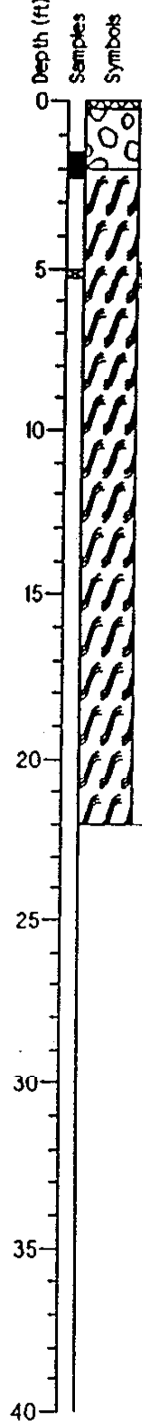
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1418		05/95	

LOG OF BORING IR09MW51F

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.	Depth (ft)
7 50/5"		9605G061	2
50/3"			5



Materials Description

ASPHALT

DARK GRAYISH BROWN WELL-GRADED GRAVEL WITH SAND (GW)
10YR4/2, medium dense, moist, 60-65% fine to coarse gravel, 30-35% fine to coarse sand, 5-10% silt, fill

GRAYISH GREEN SERPENTINITE BEDROCK (sp)
5G4/2, moist, intensely fractured, low hardness, weak, moderate to deep weathering

Moist to wet and color change to very dark gray (N3/) at 5 ft.

Too hard to sample at 9.5 ft.

Color change to greenish gray (10Y4/1) at 13 ft (logged from cuttings).

Too hard to sample at 16 ft.

Too hard to sample at 21 ft.

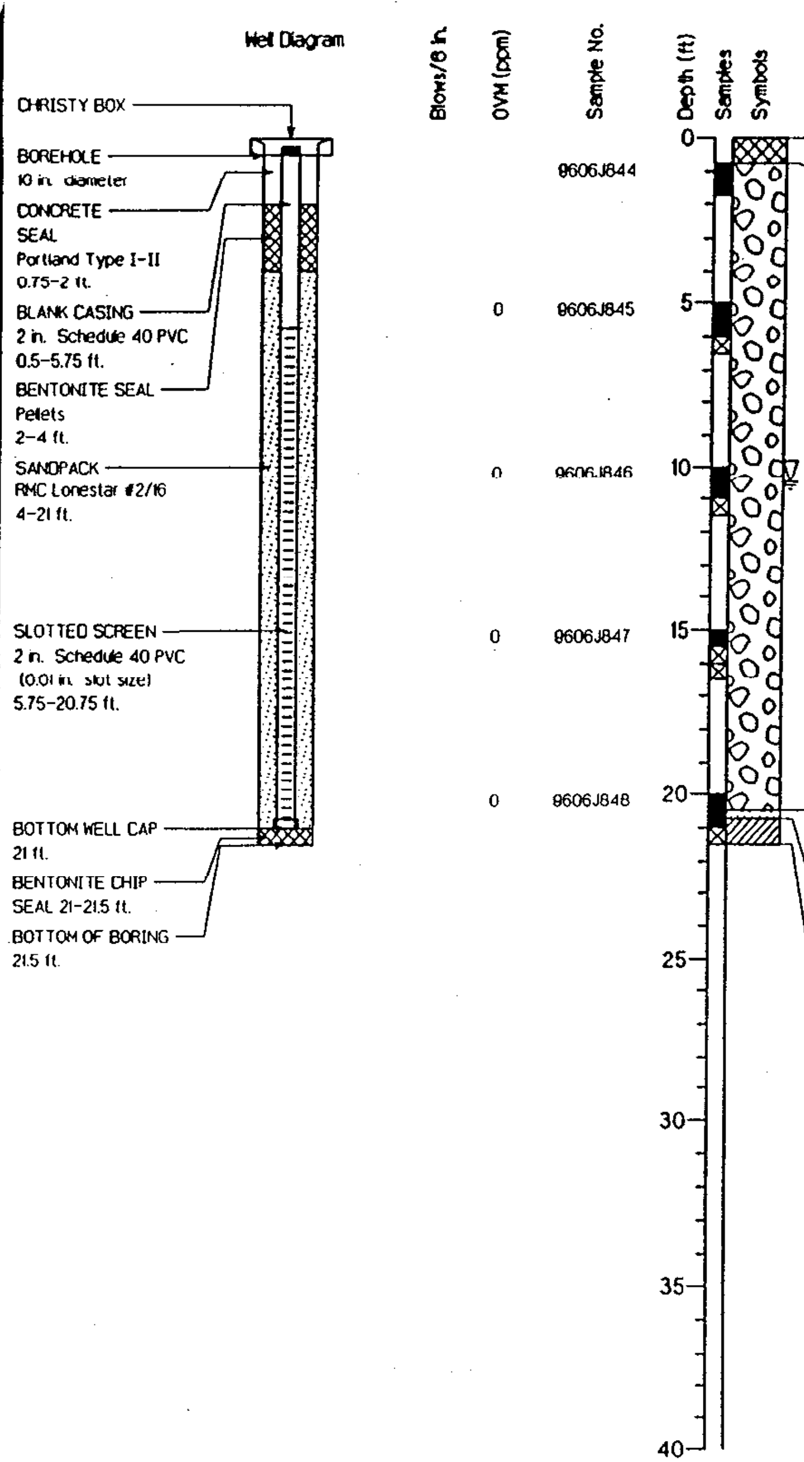
Bottom of boring at 22 feet.

Project Number	CTO 5	Date Drilled	2/1/96
Project Name	Parcel D RI Report	GS Elevation	NA
Project Task	Hunters Point Annex	First Encountered Wet Soil	5.5 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	22 ft.
Equipment	Air Rotary Casing Hammer (ARCH) 10 in. diam.		

Figure

PRC Environmental Management, Inc.

LOG OF BORING IR09MW52A



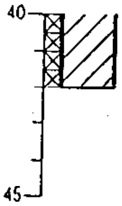
Materials Description
CONCRETE
OLIVE WELL-GRADED GRAVEL WITH SAND (GW) 5Y3/3, dense, moist, 80% serpentinite gravel, 15% coarse sand, 5% fines, fill
DARK BLUISH GRAY POORLY GRADED SAND (SP) 10B4/1, loose, wet, 85% fine sand, 5% shell fragments, undifferentiated upper sand deposits
DARK BLUISH GRAY FAT CLAY (CH) 10B4/1, soft, wet, 90% clay, 10% shell fragments, bay mud deposits
Bottom of boring at 21.5 feet. Boring backfilled with bentonite pellets to 21 feet.

Project Number	CTO 5	Date Drilled	2/6/96
Project Name	Parcel D RI Report	GS Elevation	NA
Project Task	Hunters Point Annex	First Encountered Wet Soil	10.5 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	21.5 ft.
Equipment	Hollow Stem Auger (HSA) 10 in. diam.		

Figure

Log of Boring: IR09P041A
Equipment: MOBILE B-53 (HSA), 9 in. diam.
Elevation: GS 9.44 ft.
Date: 09/11/1991
Total Depth: 42 ft.

Blows/6"	OVA (ppm)	Sample Number	Depth (ft.)	Sample
11			40	
18	0			
24				
36	0			
			45	



Bottom of boring at 42 feet. Boring backfilled with bentonite chips to 17 feet.

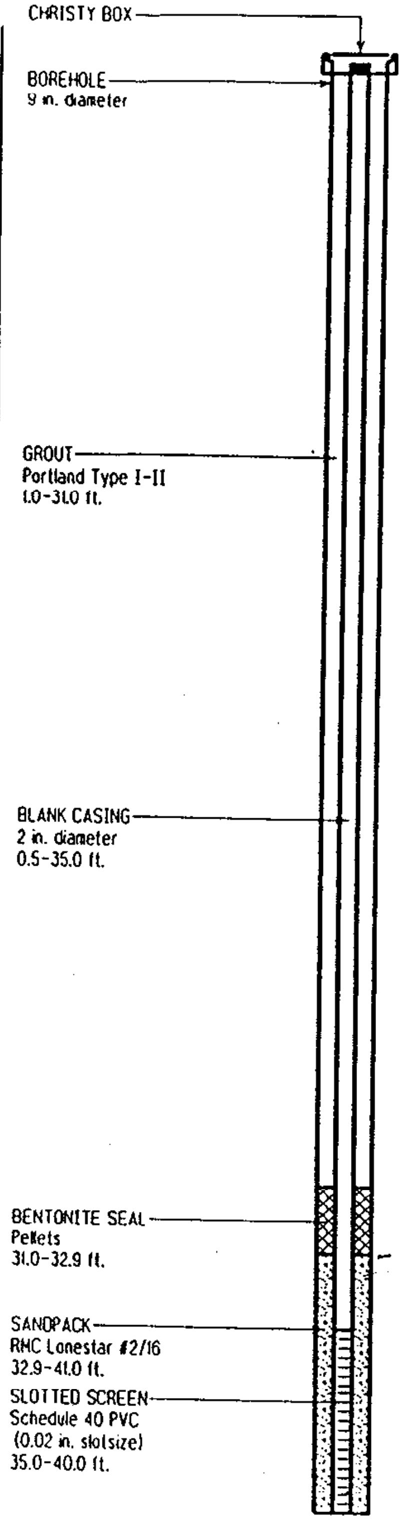
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR09P041A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

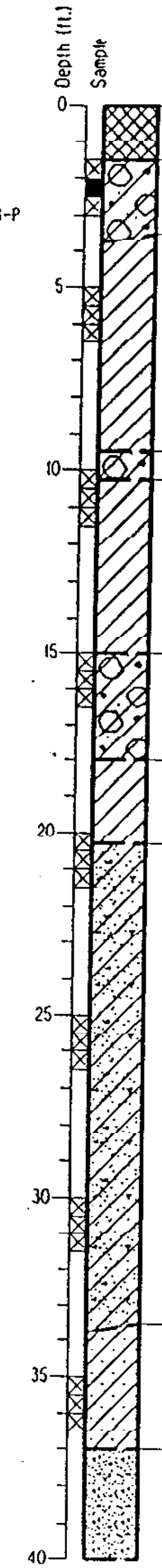
PLATE D100

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 1005		03/94	

Log of Boring: IR09P042A
Equipment: MOBILE B-53 (HSA), 9 in. diam
Elevation: GS 9.46 ft.
Date: 09/12/1991
Total Depth: 46.5 ft.



Blows/6"	OVA (ppm)	Sample Number
8, 8, 12	0	9137H873-P
5, 5, 6	0	
4, 5, 11	0	
6, 14, 29	0	
9, 13, 11	0	
7, 13, 16	0	
2, 2, 4	0	
6, 7, 11	0	



CONCRETE SLAB

DARK YELLOWISH BROWN CLAYEY GRAVEL WITH SAND (GC)
10YR4/4, dense, moist,
40-50% fine to medium gravel, 30% medium- to fine-grained sand,
20-30% clay, some cobbles, fill

OLIVE BROWN GRAVELLY LEAN CLAY WITH SAND (CL)
2.5Y4/4, medium stiff to stiff, moist,
60% clay, 20% very fine to fine gravel,
20% fine- to medium-grained sand, trace medium to coarse
weathered serpentinite gravel, trace wood debris, fill

DARK GREENISH GRAY CLAYEY GRAVEL (GC)
5G4/1, medium dense, moist to wet,
80% fine to medium rounded to subrounded serpentinite gravel,
20% clay, trace sand, fill

OLIVE GRAVELLY LEAN CLAY (CL)
4Y4/3, soft, moist,
70% clay, 20% fine to medium serpentinite and chert gravel,
10% fine- to medium-grained sand, fill

▽ Wet at 15 ft.

GREENISH GRAY WELL-GRADED GRAVEL WITH CLAY (GW-GC)
5GY5/1, loose, wet,
80% fine to coarse chert and serpentinite gravel,
10% clay, 10% medium-grained sand, fill

BLACK SILTY LEAN CLAY (CL)
5Y2.5/1, stiff, dry to moist,
90% clay, 10% silt, trace rootlets, fill

DARK GREENISH GRAY CLAYEY SAND (SC)
5GY4/1, medium dense, moist,
60-70% fine-grained sand, 30-40% fat clay,
some to mostly shell fragments

DARK GREENISH GRAY POORLY GRADED SAND WITH CLAY (SP-SC)
5GY4/1, loose, wet,
90% fine-grained sand, 10% clay, few shell fragments

LIGHT OLIVE BROWN POORLY GRADED SAND (SP)
2.5Y5/4, loose, wet,
95% very fine- to medium-grained sand, 5% silt

Harding Lawson Associates
Engineering and
Environmental Services

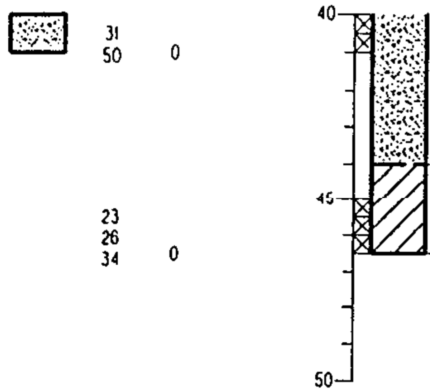
Log of Boring and Well Completion IR09P042A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE
D101

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 1005		03/94	

Log of Boring: IR09P042A
Equipment: MOBILE B-53 (HSA), 9 in. diam.
Elevation: GS 9.46 ft.
Date: 09/12/1991
Total Depth: 46.5 ft.

Blows/6"	OVA (ppm)	Sample Number	Depth (ft.)
31 50	0		40
23 26 34	0		45
			50



DARK YELLOWISH BROWN SANDY CLAY (CL)
10YR4/0, very stiff, dry to moist,
70% clay, 30% fine-grained sand,
Undifferentiated Sedimentary deposits

Bottom of boring at 46.5 feet. Boring backfilled with bentonite chips to 41 feet.

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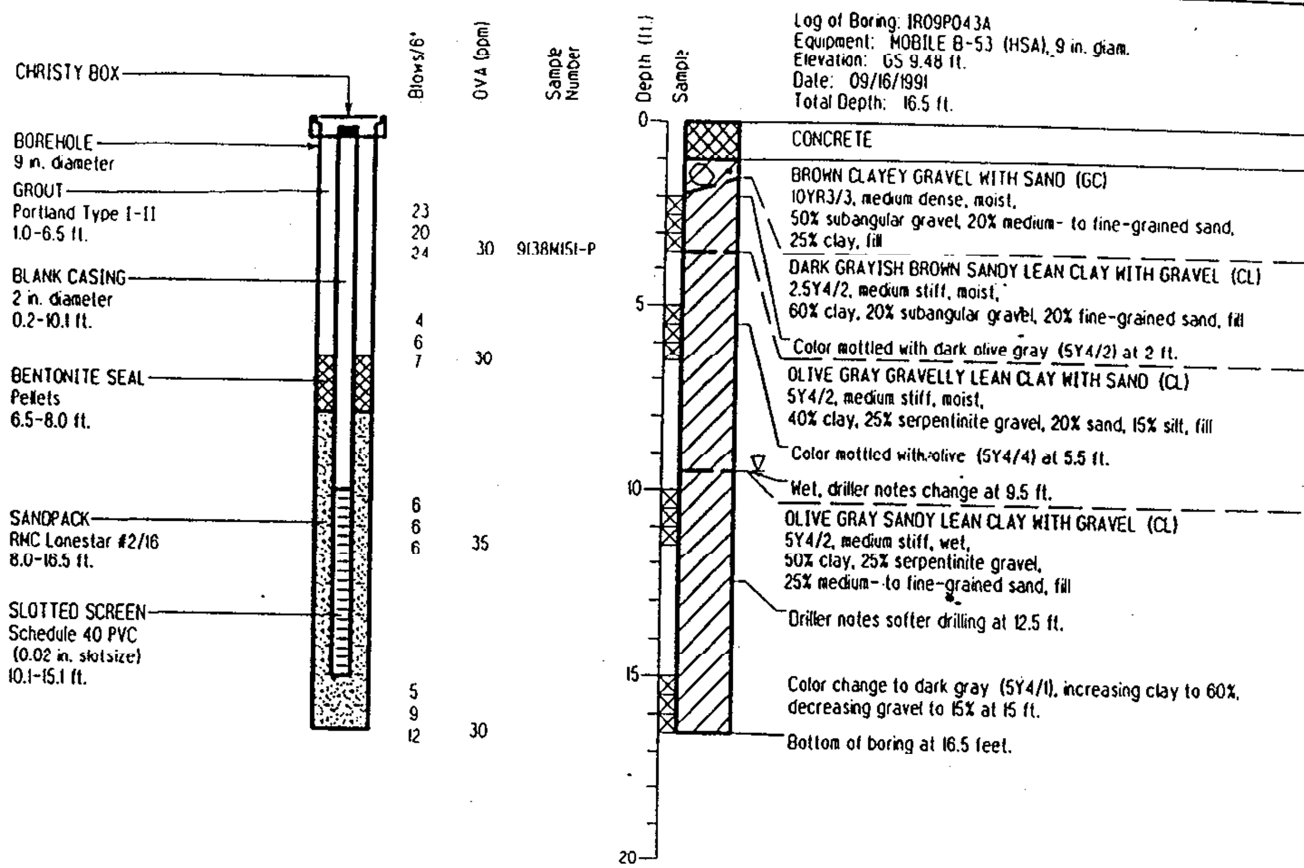
Log of Boring and Well Completion IR09P042A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE D101

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 1005		03/94	



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Log of Boring and Well Completion IR09P043A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

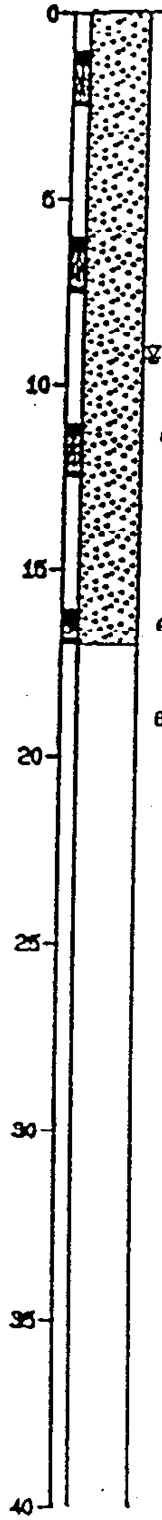
PLATE
D102

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 1005		03/94	

Equipment Failing FA-100

Elevation ft*** Date 6/15/89

Blows/Ft	OVA (ppm)	Depth (ft) / Sample	Description
		0	MEDIUM REDDISH BROWN GRAVELLY SAND (SW) 10R 4/6 medium dense, dry (10% gravel, 90% medium to fine sand)
			GRAYISH BROWN GRAVELLY SAND (SW) 5YR 3/2 loose (15% clasts of black gabbro, 85% medium to fine sand)
			GREENISH BLACK GRAVELLY SAND (SW) 5GY 2/1 loose, wet (10% gravel, 85% fine sand, 5% silt)
			GREENISH BLACK GRAVELLY SAND (SW) 5GY 2/1 dense, wet, large clasts of gabbro and altered clays (20% gravelly sand, 30% solid gabbro, 50% altered serpentine)
			Bottom of boring at 17 ft



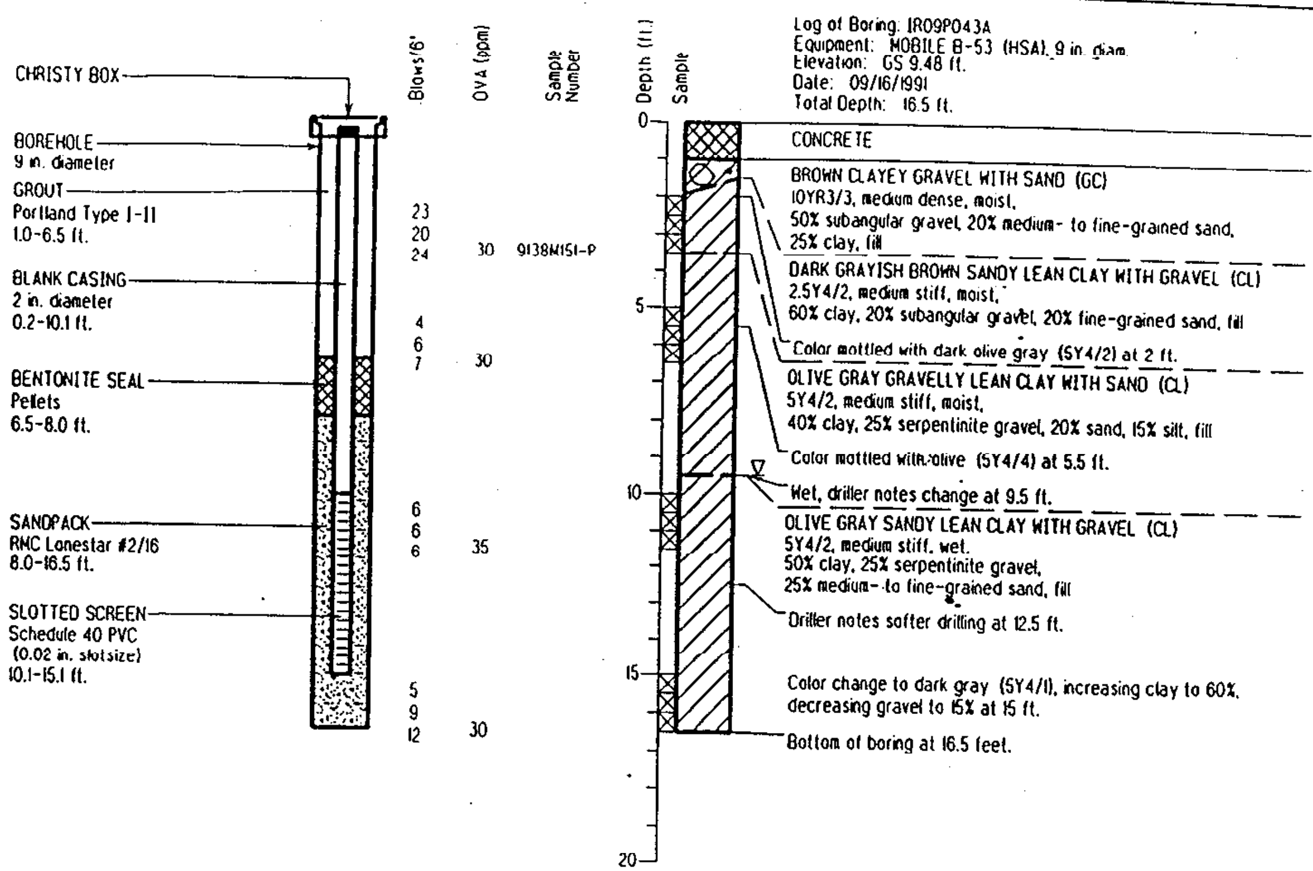
Harding Lawson Associates
Engineers and Geoscientists

Log of Boring PPY-1
Hunters Point Annex
San Francisco, California

PLATE
B-2

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	2176,245.02		8/89		

From: Sampling at the Pickling and Plate Ya



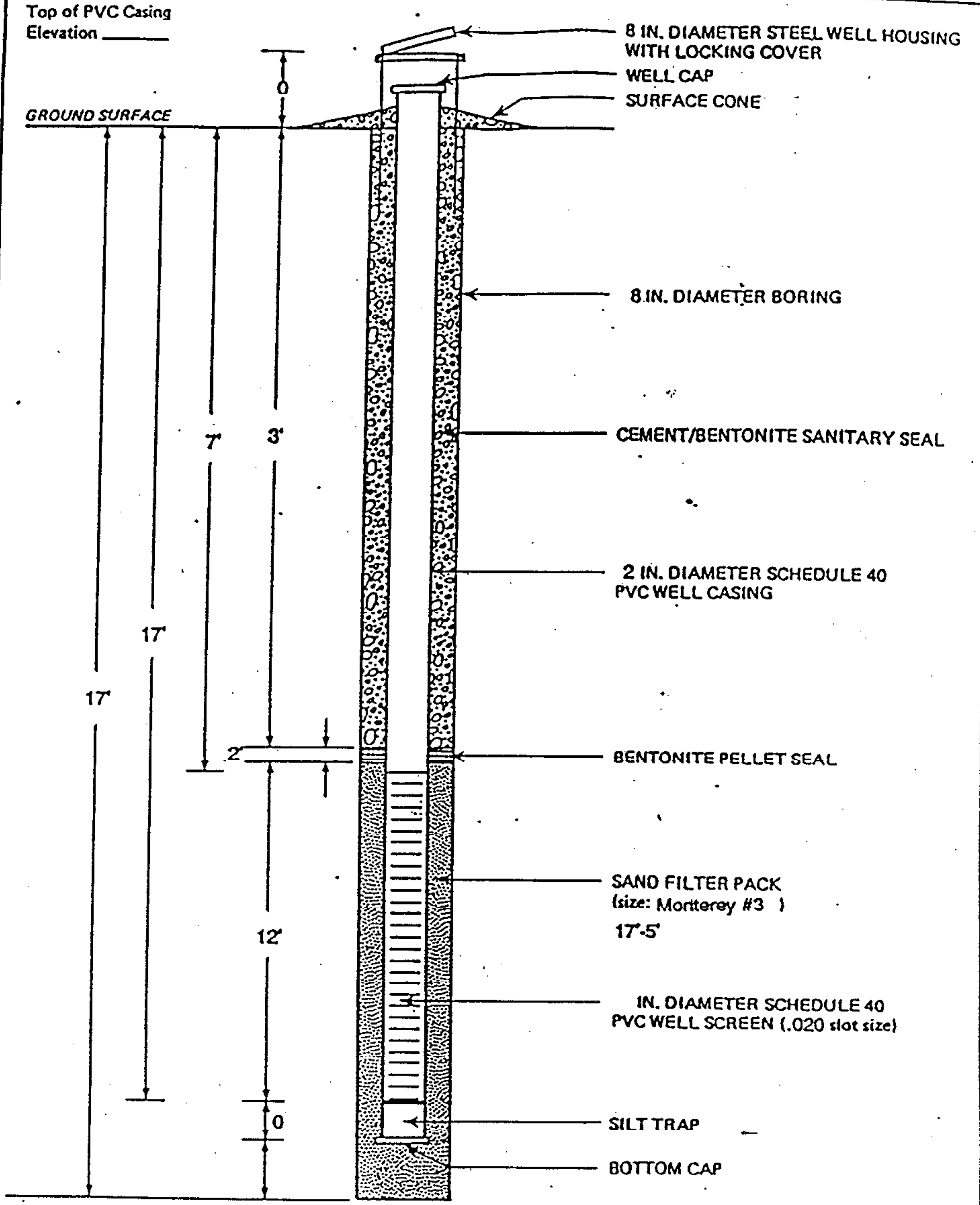
Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR09P043A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE
D102

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 1005		03/94	

IR04PPY



NOT TO SCALE

Harding Lawson Associates
Engineers, Geologists & Geophysicists

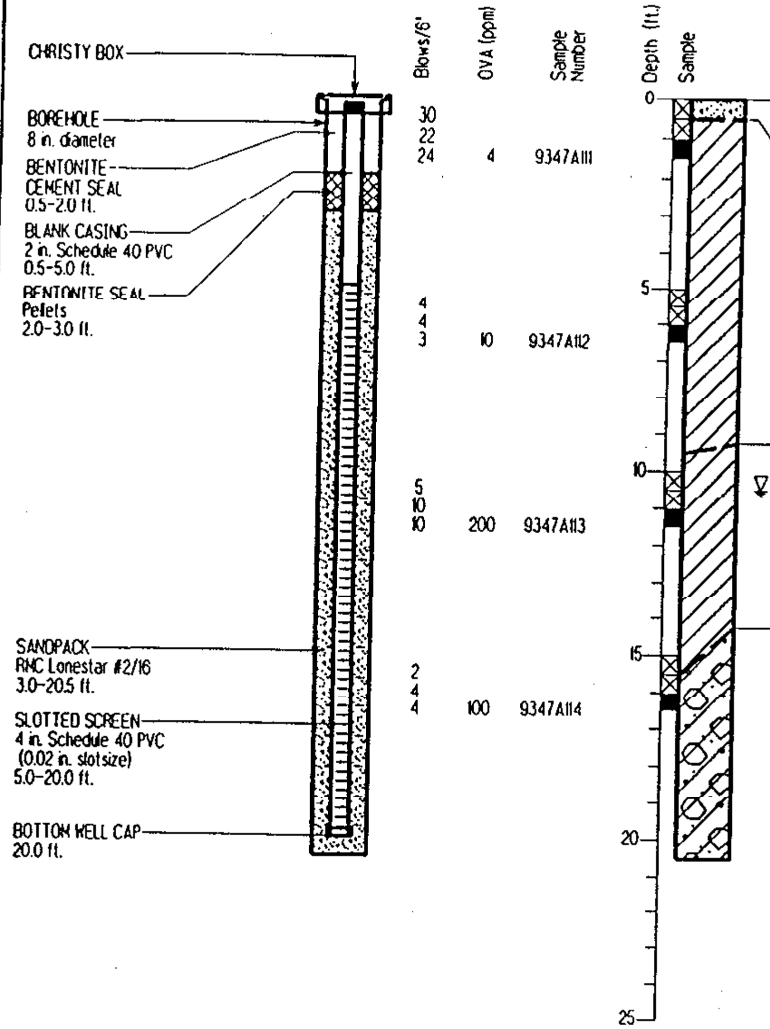
Well Completion Detail
Hunters Point Annex
San Francisco, California

PLATE **B-3**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	02176,245.02		10/89		

FORM GW1

Log of Boring: IR25MW11A
Equipment: Limited Access Rig (CFA), 3 in. diam.
Elevation: GS 11.06 ft.
Date: 11/24/1993
Total Depth: 20.5 ft.



OLIVE GRAY POORLY GRADED SAND (SP)
5Y4/2, dense, moist,
90% fine sand, 10% lean clay, fill

DARK BROWN SANDY LEAN CLAY WITH GRAVEL (CL)
10YR3/3, stiff, moist,
55% clay, 25% fine sand, 20% fine to coarse subangular serpentinite gravel, fill

Color change to dark bluish gray (5B4/1), soft, 95% clay, 5% medium to very coarse sand at 5 ft.

DARK BLUISH GRAY SANDY LEAN CLAY (CL)
5B4/1, medium stiff, wet,
60% clay, 40% medium to coarse sand,
strong product sheen, fill

DARK GREENISH GRAY CLAYEY GRAVEL WITH SAND (GC)
5GY4/1, loose, wet,
55% fine to coarse serpentinite gravel, 30% fine to coarse sand, 15% lean clay, product sheen, fill

Bottom of boring at 20.5 feet. Grab groundwater sample 9347A115 collected.

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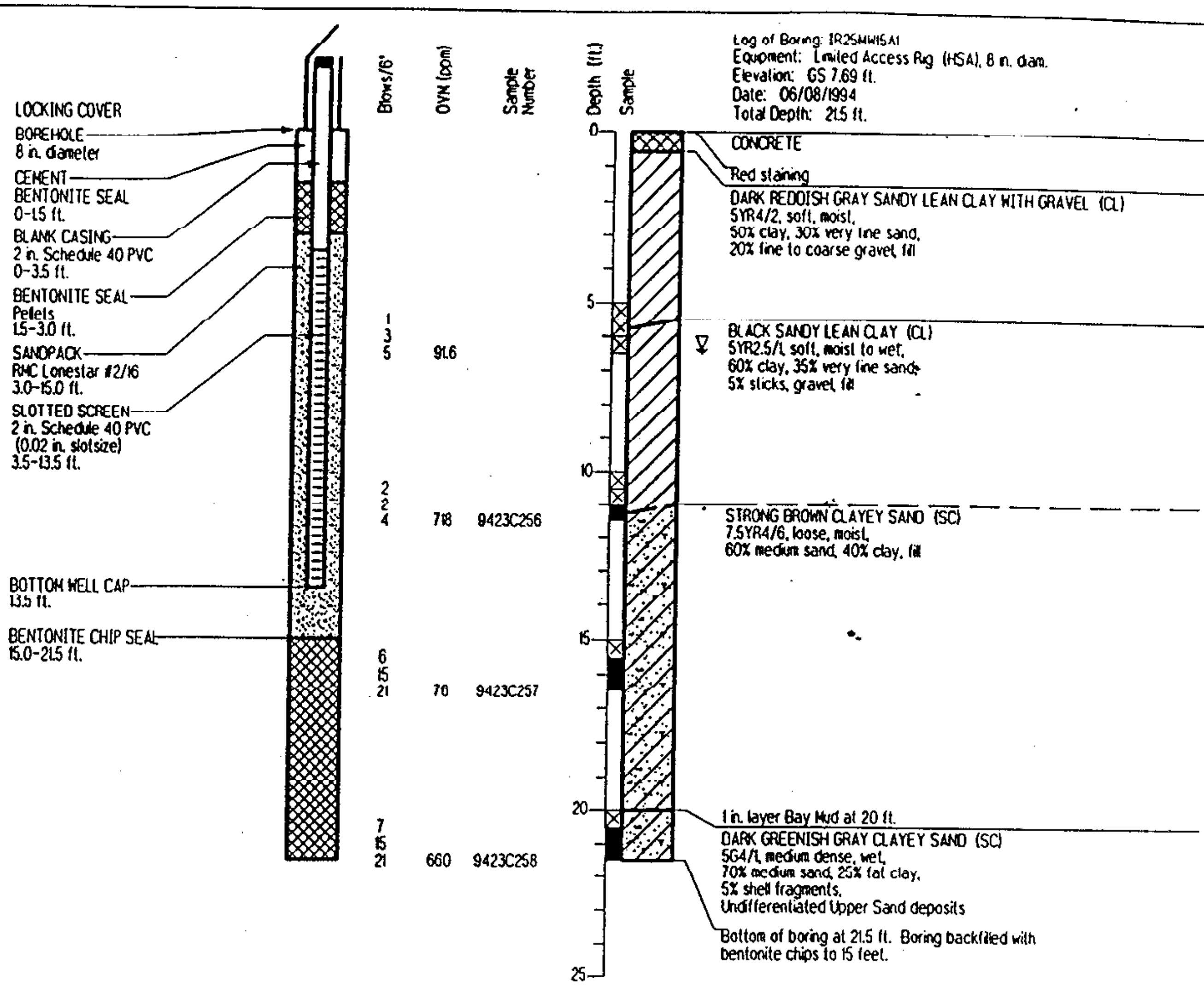
Log of Boring and Well Completion IR25MW11A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 1402		07/94	06/02/94



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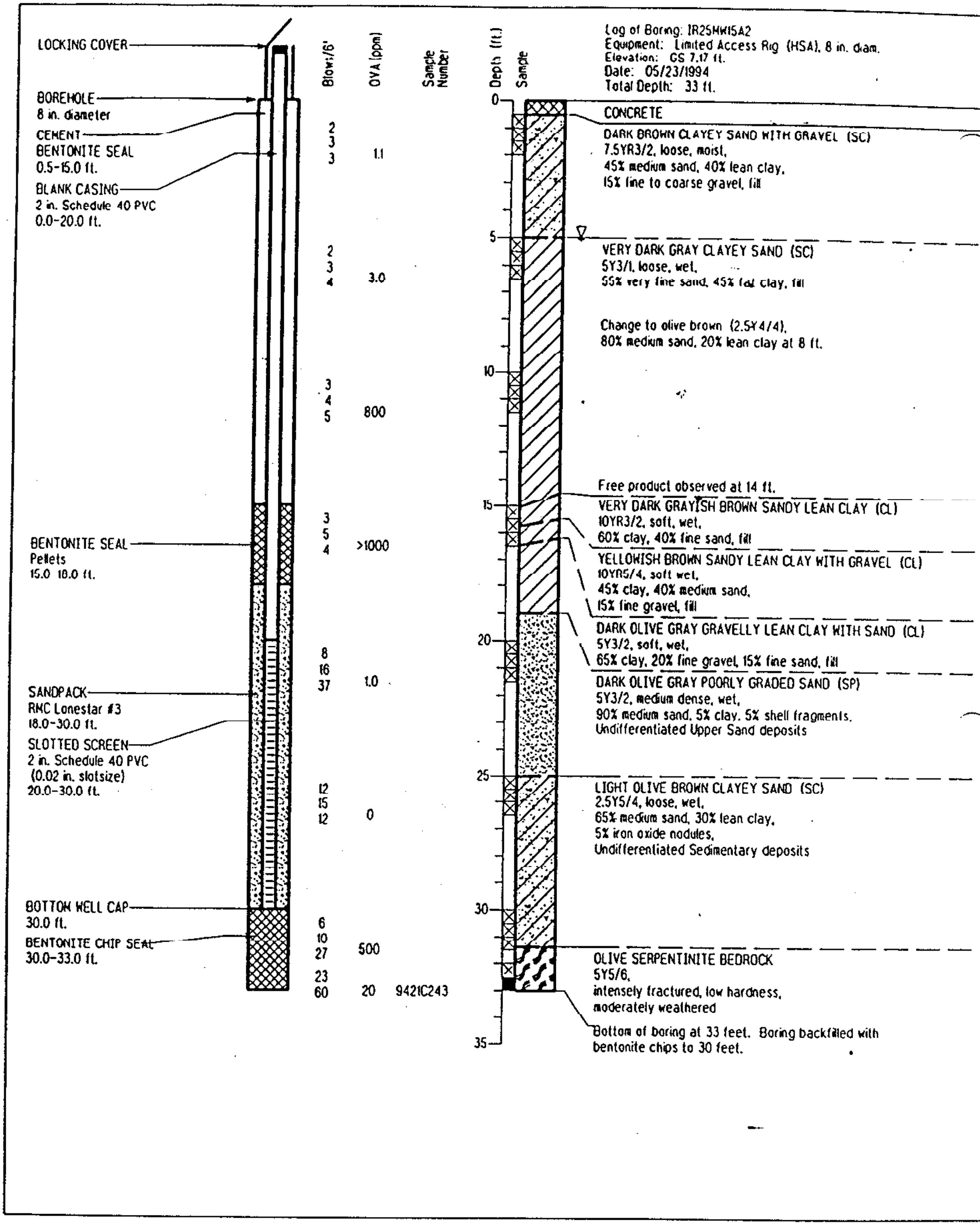
Environmental Services

Log of Boring and Well Completion IR25MW15A1
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1402		08/94	



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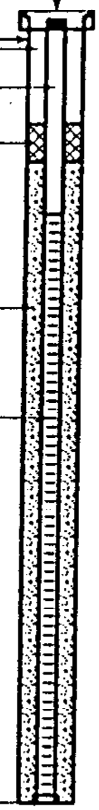
Environmental Services

Log of Boring and Well Completion IR25MW15A2
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

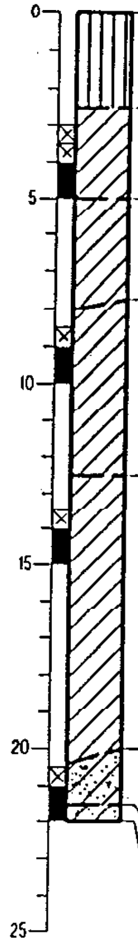
PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1402		08/94	

Log of Boring: IR25MW16A
Equipment: CME 95 (HSA), 10 in. diam.
Elevation: GS 11.62 ft.
Date: 05/23/1994
Total Depth: 22 ft.



Blows/6"	OVA (ppm)	Sample Number
4 6 8	70	9421A854
4 4 4	4	9421A855
2 2 3	1	9421A856
7 12 13	20	9421A857



DARK BROWN SANDY SILT WITH GRAVEL (ML)
10YR3/3, medium dense, dry,
50% silt, 30% fine to coarse sand,
20% fine to coarse serpentinite
gravel, fill

BLACK SANDY LEAN CLAY WITH GRAVEL (CL)
5Y2.5/1, soft, moist,
60% clay, 20% fine to coarse sand,
20% fine to coarse gravel,
black sticky product, fill

OLIVE GRAY SANDY LEAN CLAY (CL)
soft, moist,
70% clay, 30% fine to coarse sand, fill

BROWN LEAN CLAY (CL)
10YR4/3, soft, moist,
90% clay, 10% fine sand, fill

OLIVE SANDY LEAN CLAY WITH GRAVEL (CL)
5Y5/4, soft, moist,
65% clay, 20% fine to coarse sand, 15% fine
to medium serpentinite gravel, fill

DARK GRAY CLAYEY SAND (SC)
N4/, medium dense, wet,
55% fine to medium sand, 35% lean clay,
10% shell fragments,
Undifferentiated Upper Sand deposits

DARK YELLOWISH BROWN CLAYEY SAND (SC)
10YR4/4, medium dense, moist,
80% fine to medium sand,
20% fat clay, Undifferentiated Sedimentary deposits

Bottom of boring at 22 feet

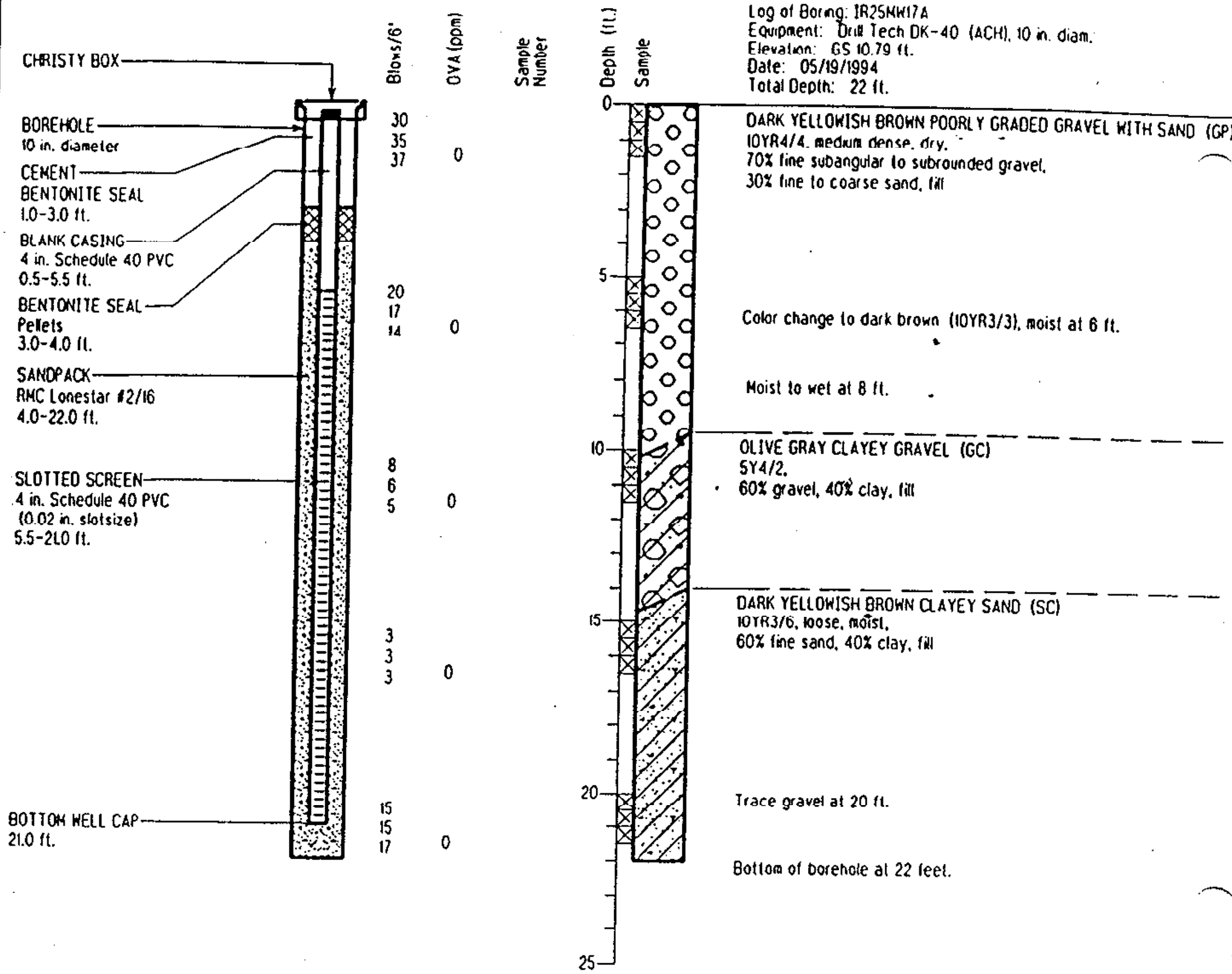
Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR25MW16A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
TLB	11400 1402		08/94	

Log of Boring: IR25MW17A
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation: GS 10.79 ft.
Date: 05/19/1994
Total Depth: 22 ft.



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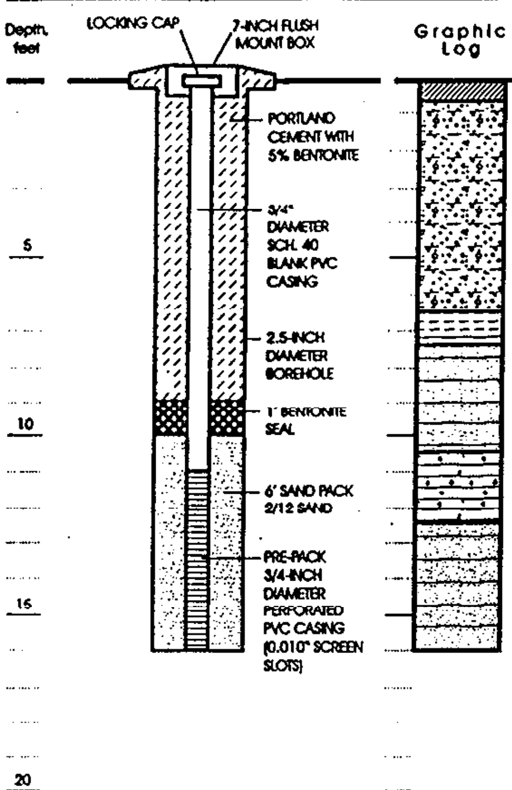
Log of Boring and Well Completion IR25MW17A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1402		08/94	

WELL CONSTRUCTION	LITHOLOGY	SAMPLE DATA



Description

ASPHALT 2".
Hand Augered to 5'.

SILTY GRAVEL (GM), dark yellowish brown (10YR 4/4), 40% silt, 60% gravel, slightly moist, loose, trace clays.

CLAYEY SILT (ML), dark reddish brown (2.5YR 3/4), moist, hard, medium plasticity, 40% clay.

CLAYEY SAND (SC), dark yellowish brown (10YR 4/6), moist, firm, 20% clay, 80% fine sand, subround to round, medium plasticity.

GRAVELLY CLAY (CL), olive (5Y 5/3), moist, firm 25% gravel, 75% clay (weathered serpentine)

CLAYEY SAND (SC) dark yellowish brown (10YR 4/6), moist, firm, 20% clay, 80% fine sand, subround to round.

BOTTOM OF BORING AT 16 FEET.

Sample Interval | Penetration Rate (Blows/ft.) | PID (ppm)

Well Permit No:
Date Well Drilled: December 18, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION

Clay
Silt
Sand
Gravel

Interval sampled using Push Point Sampler
Soil sample collected for analysis
ATD Depth first water was encountered in borehole

Approved by: Todd A. Miller RG 6568

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR25MW18A *(page 1 of 1)*

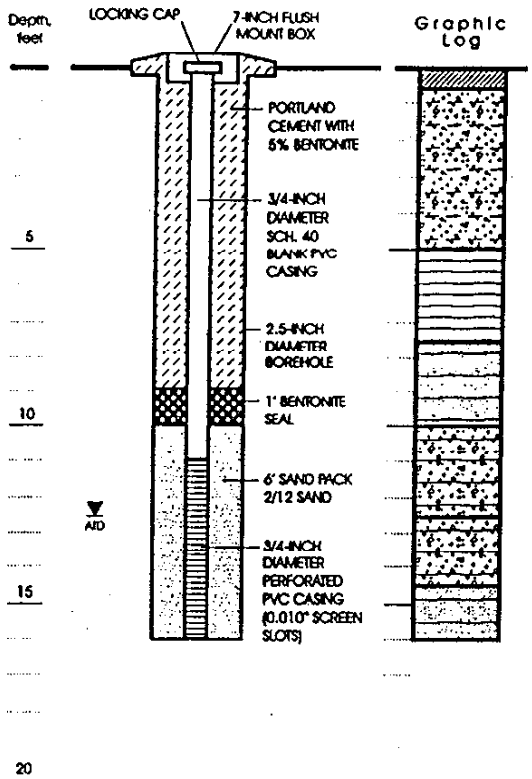
Levine·Fricke·Recon

Figure

Project No. 5109

5109L011.CDR 040398

WELL CONSTRUCTION | LITHOLOGY | SAMPLE DATA



Description

ASPHALT SURFACE, 7" THICK.
Hand Augered to 5'.
SILTY GRAVEL (GM), dark olive gray (5Y 3/2), slightly moist, 25% silt, 75% serpentine rock, angular, trace clays.

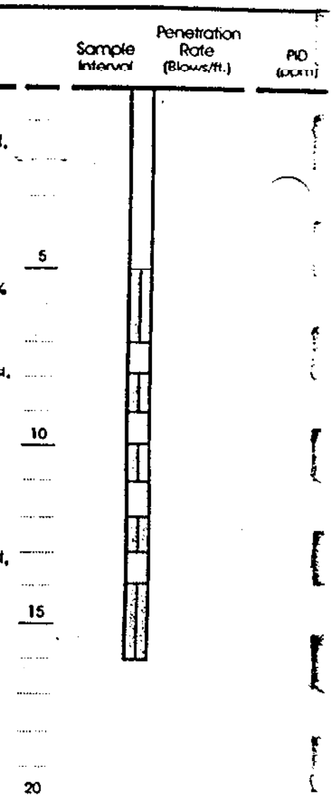
SANDY CLAY (CL), black (2.5Y N2/0), moist, firm (stiff), 20% very fine sand, 80% clay, decayed grass.

CLAYEY SAND (SC), dark yellowish brown (10YR 3/6), moist, soft, 10% clay, 90% very fine sand, subround to round.

CLAYEY GRAVEL (GC), dark greenish gray (5GY 4/1/0, moist, soft, 45% clay, 55% serpentine rock <1cm, odor.

CLAYEY GRAVEL (GC), dark greenish gray (5GY 4/1), moist, soft, 20% clay, 80% serpentine rock, well graded up to 3cm, slight odor.
CLAYEY SAND (SC), dark olive gray (5Y 3/2), moist, 20% clay, 80% very fine sand, subround to round, slight odor.

BOTTOM OF BORING AT 16 FEET.



Well Permit No:
Date Well Drilled: December 18, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION

- Clay
- Silt
- Sand
- Gravel
- Interval sampled using Push Point Sampler
- Soil sample collected for analysis
- ATD Depth first water was encountered in borehole

Approved by: [signature] RG 5568

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR25MW19A *(page 1 of 1)*

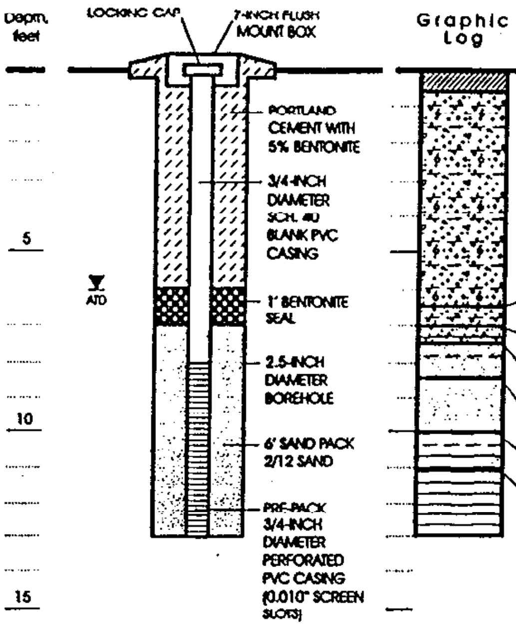
Levine·Fricke·Recon

Figure

Project No. 5109

5109L013.CDR 0-

WELL CONSTRUCTION	LITHOLOGY	SAMPLE DATA



Description

ASPHALT 2".

SILTY GRAVEL (GM), reddish brown (5YR 4/4), slightly moist, loose, 30% silt, 70% gravel, serpentine rock, slickenside.

No recovery.

SILTY GRAVEL (GM), dark yellowish brown (10YR 4/6), slightly moist, loose, 30% silts, 70% serpentine rock.

CLAYEY GRAVEL (GC), very dark brown (10YR 2/2), moist, soft, 30% clay 70% gravel, 4" thick interval.

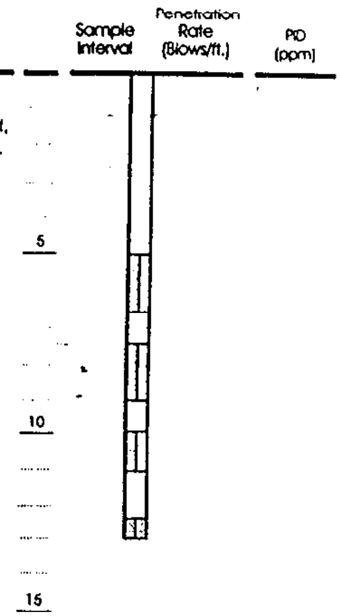
SILTY SAND (SM), very dark grayish brown (10YR 3/2), soft, 8" thick.

SAND (SW), dark grayish brown (10YR 4/2), wet, loose, 4" thick.

SANDY SILTY CLAY (CL), dark greenish gray (5BG 4/1), moist, soft, 20% sand, 30% silt, 50% clay, low plasticity.

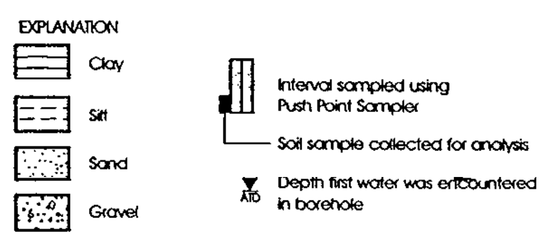
SANDY CLAY (CL), dark brown (10YR 3/3), wet, soft, 45% sand, 55% clay.

BOTTOM OF BORING AT 13 FEET.



Well Permit No:
Date Well Drilled: December 18, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION



Approved by: [signature] RG 6568

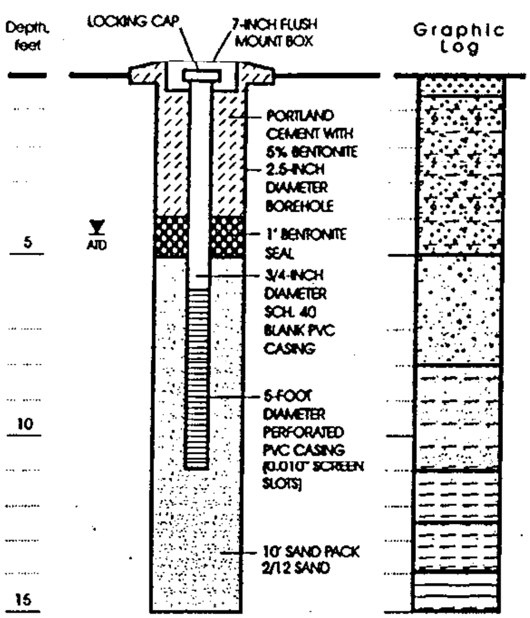
WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR25MW20A *(page 1 of 1)*

Levine·Fricke·Recon
Project No. 5109

Figure

5109L014.CDR 040398

WELL CONSTRUCTION | LITHOLOGY | SAMPLE DATA



Description

CEMENT 6".
Hand Augered to 5'.

SILTY GRAVEL (GM), very dark gray (5YR 3/1), moist, 70% silt, 30% gravel, trace clay, serpentine gravel up to 3" loose.

GRAVELLY SAND (GP), greenish gray (5G 6/1), dry, serpentine, sand and gravel, 50% sand, 50% gravel, trace silt, loose.

SILTY SAND (SM), very dark gray (5Y 3/1), moist, 40% silt, 60% sand, trace clay.

SANDY SILT (ML), dark reddish brown (5YR 3/2), moist, 50% sand, 55% silt, trace clay, soft.

SANDY SILT (ML), dark reddish brown (5YR 3/2), moist, very soft.

SILTY CLAY (CL), strong brown (7.5YR 4/6), moist, very soft, 20% silt, 80% clay.

BOTTOM OF BORING AT 15 FEET.

Depth	Sample Interval	Penetration Rate (Blows/ft.)	PID (ppm)
5			
10			
15			

Well Permit No:
Date Well Drilled: December 18, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION

- Clay
- Silt
- Sand
- Gravel
- Interval sampled using Push Point Sampler
- Soil sample collected for analysis
- ATD Depth first water was encountered in borehole

Approved by: [signature] RG6564

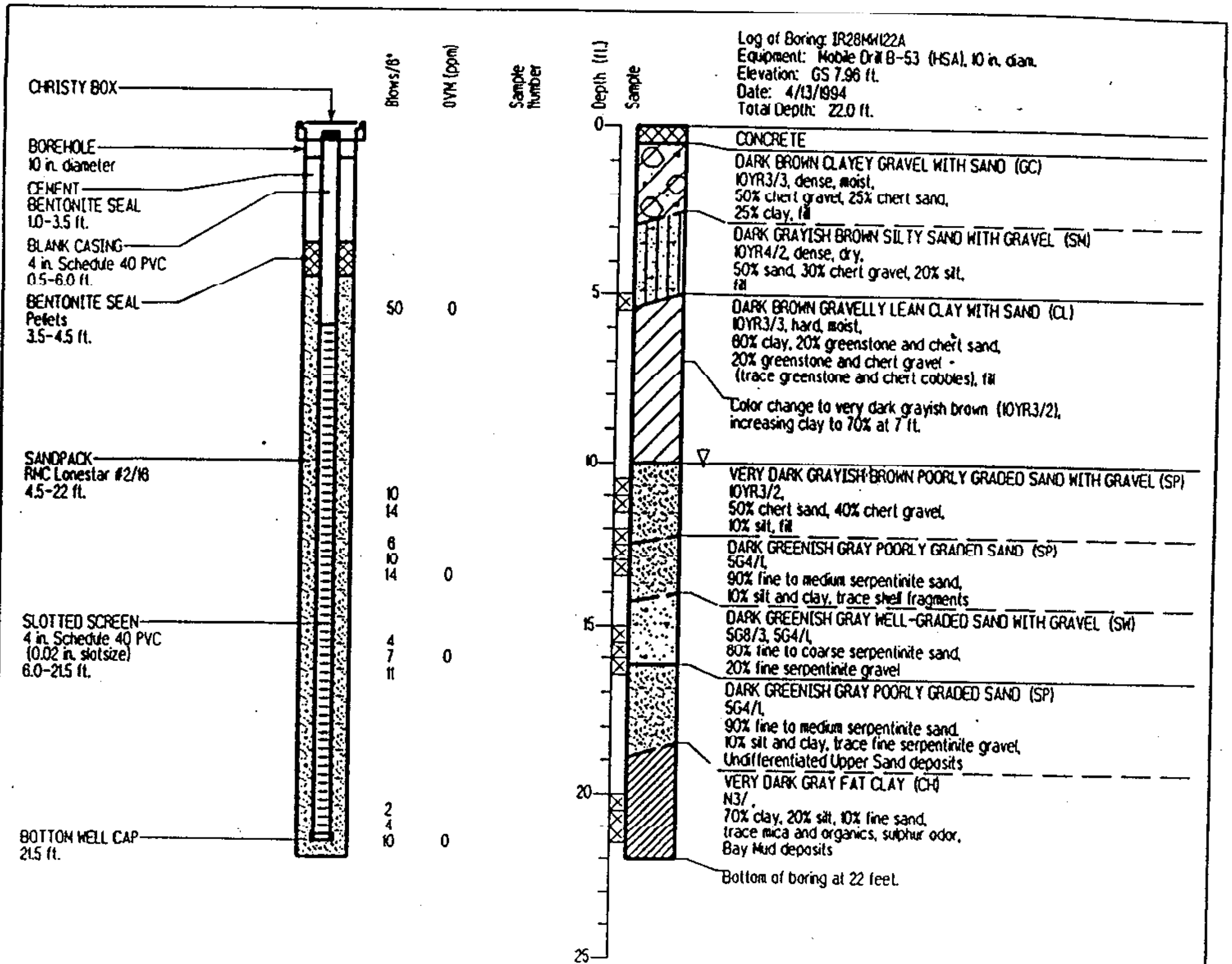
WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR25MW22A *(page 1 of 1)*

Levine·Fricke·Recon

Project No. 5109

Figure

5109L015.CDR 0-



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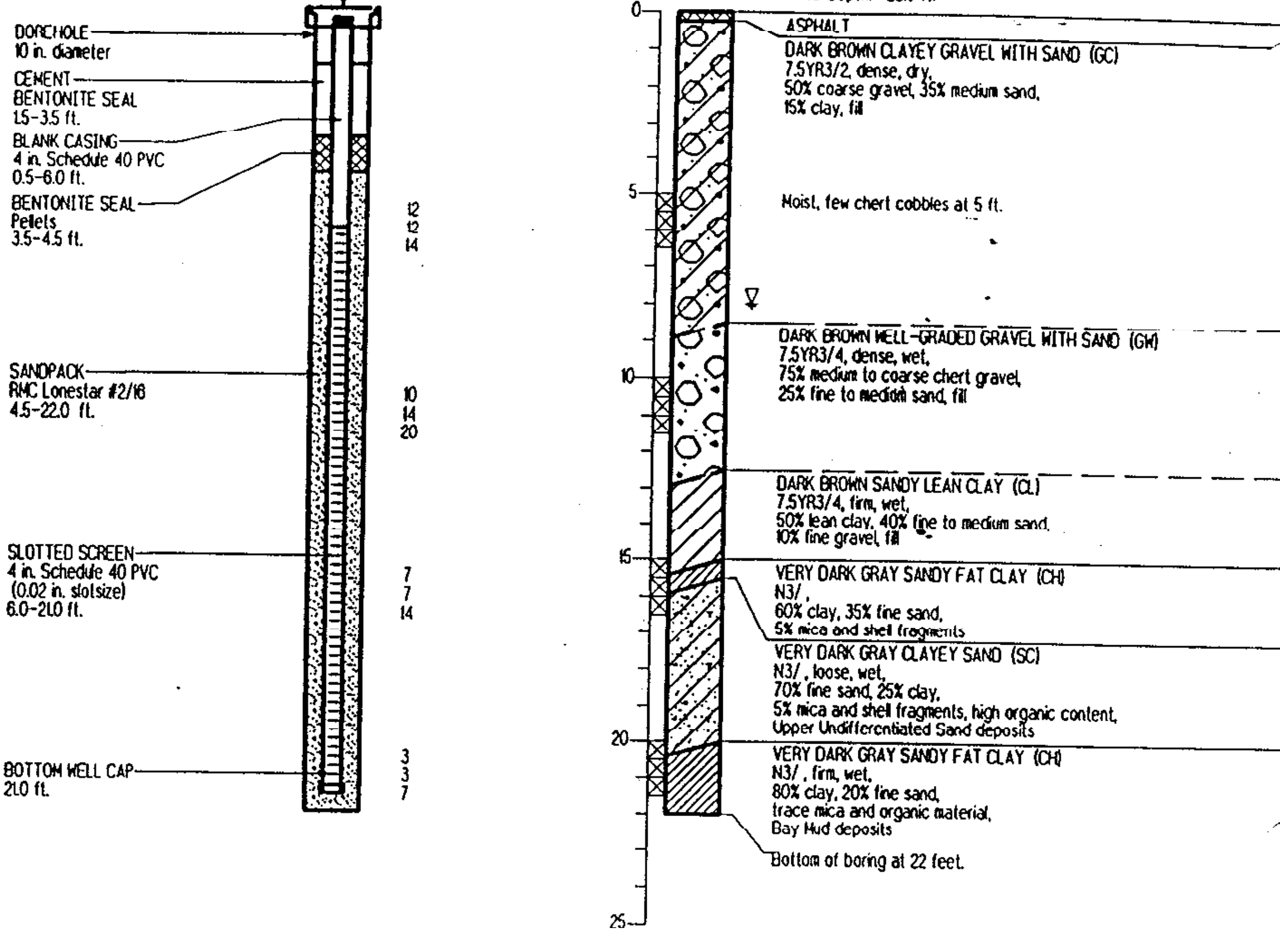
Log of Boring and Well Completion IR28MW122A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1418		08/94	

Log of Boring: IR28MW123A
Equipment: Mobile Drill B-53 (HSA), 10 in. diam.
Elevation: GS 8.34 ft.
Date: 4/15/1994
Total Depth: 22.0 ft.



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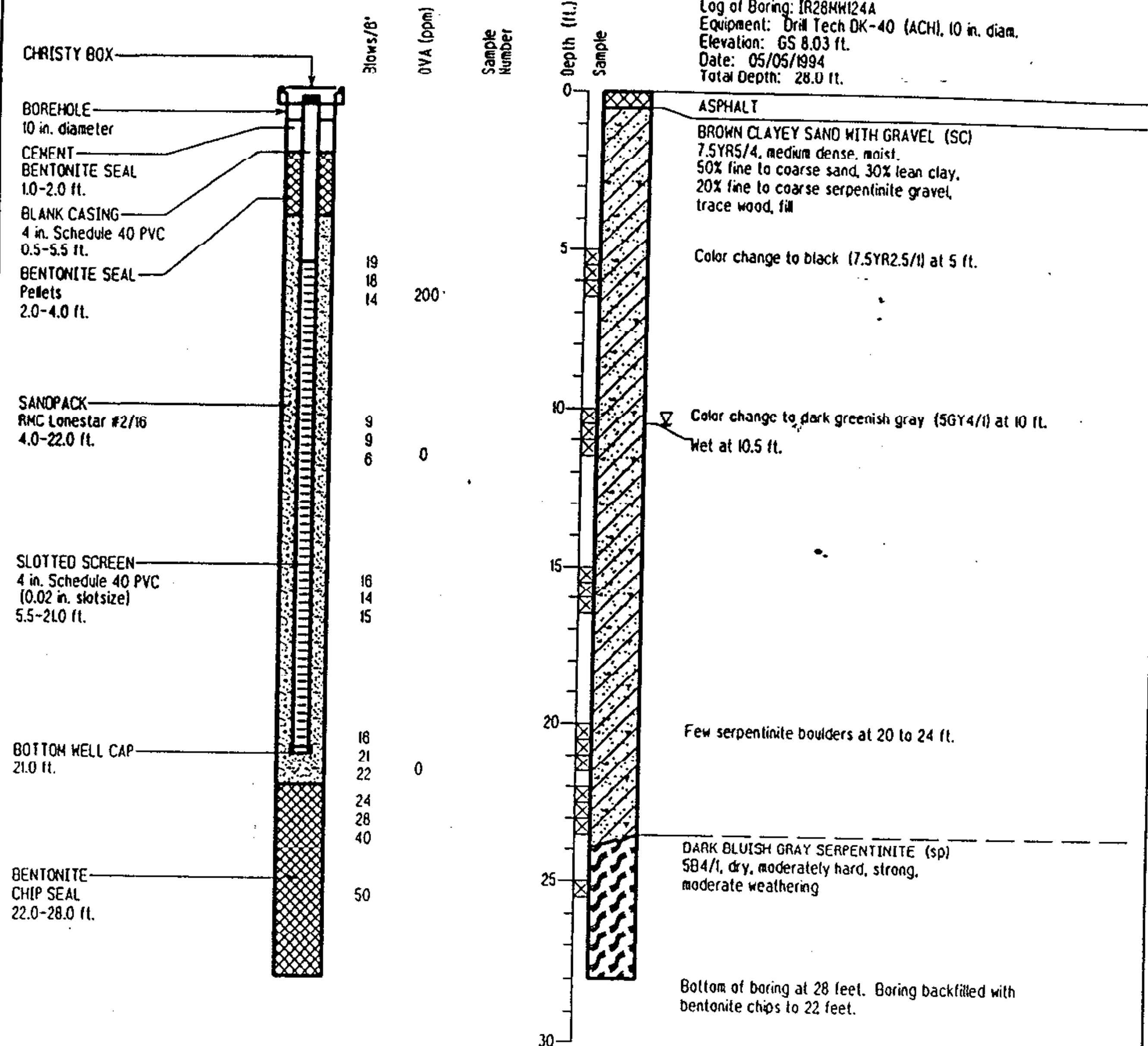
Log of Boring and Well Completion IR28MW123A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	

Log of Boring: IR28MW124A
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation: GS 8.03 ft.
Date: 05/05/1994
Total Depth: 28.0 ft.



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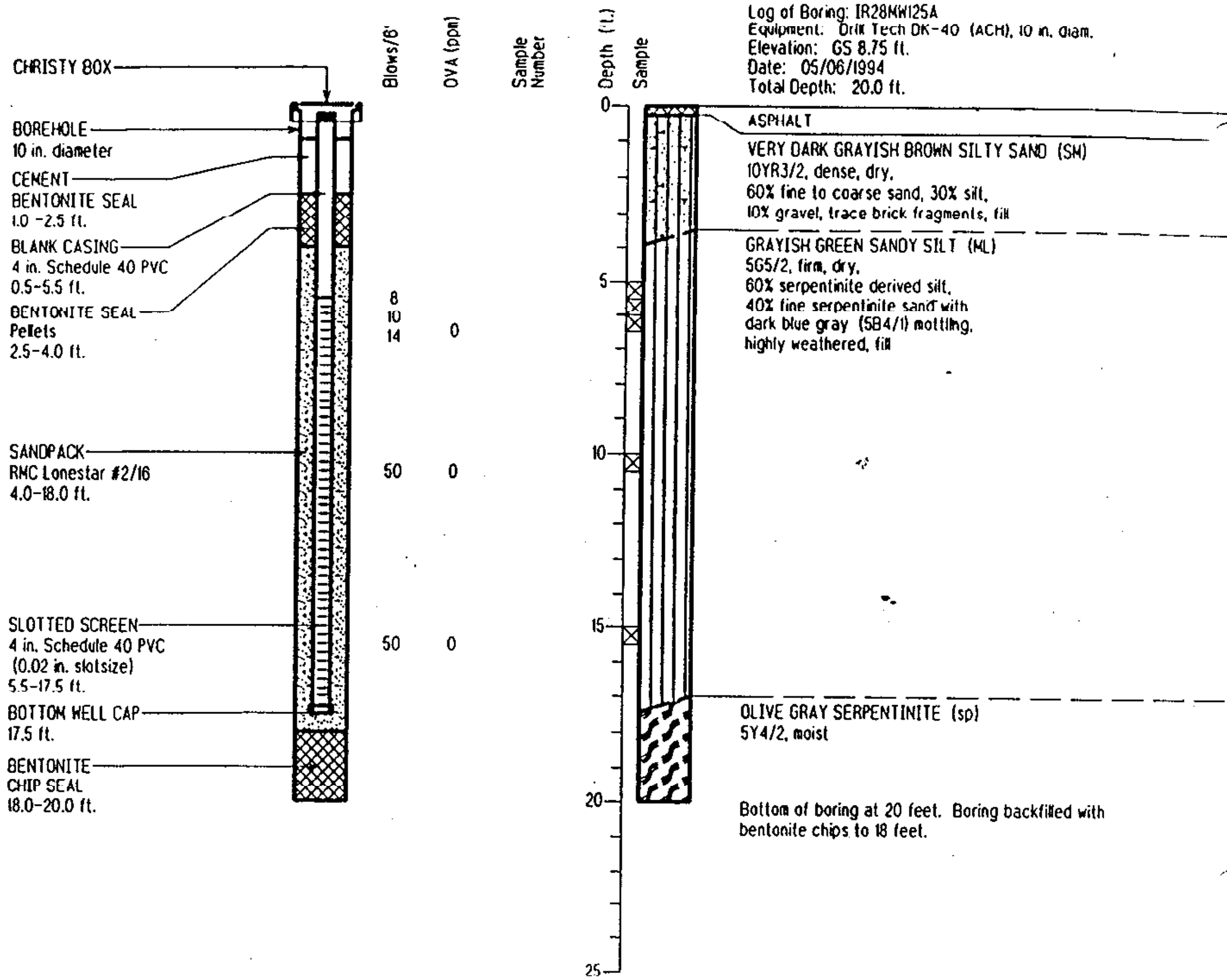
Log of Boring and Well Completion IR28MW124A
Parcel C Site Inspection Report
Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	



Log of Boring: IR28MW125A
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation: GS 8.75 ft.
Date: 05/06/1994
Total Depth: 20.0 ft.

Bottom of boring at 20 feet. Boring backfilled with bentonite chips to 18 feet.

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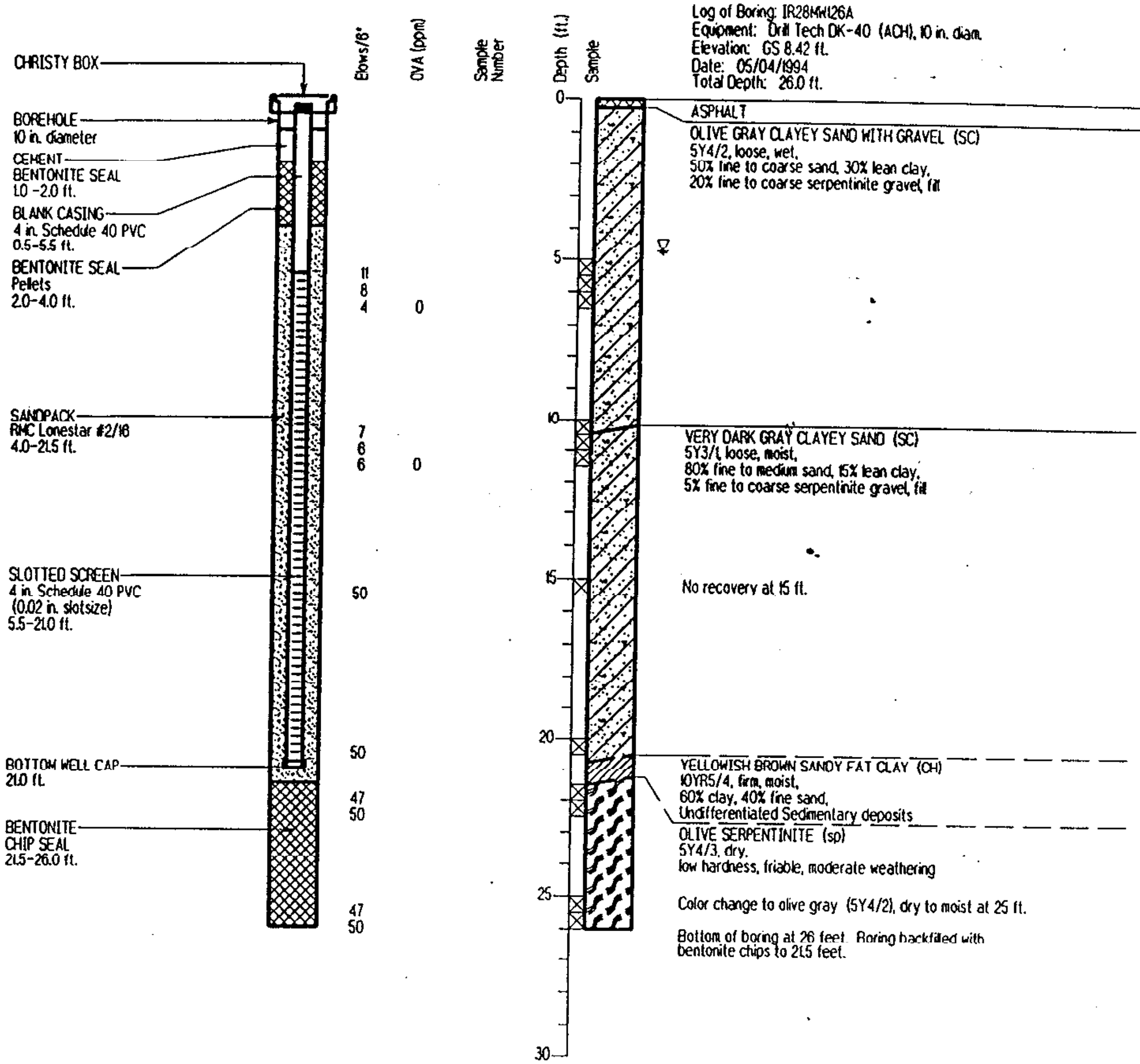
Log of Boring and Well Completion IR28MW125A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	

Log of Boring: IR28MW126A
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation: GS 8.42 ft.
Date: 05/04/1994
Total Depth: 26.0 ft.



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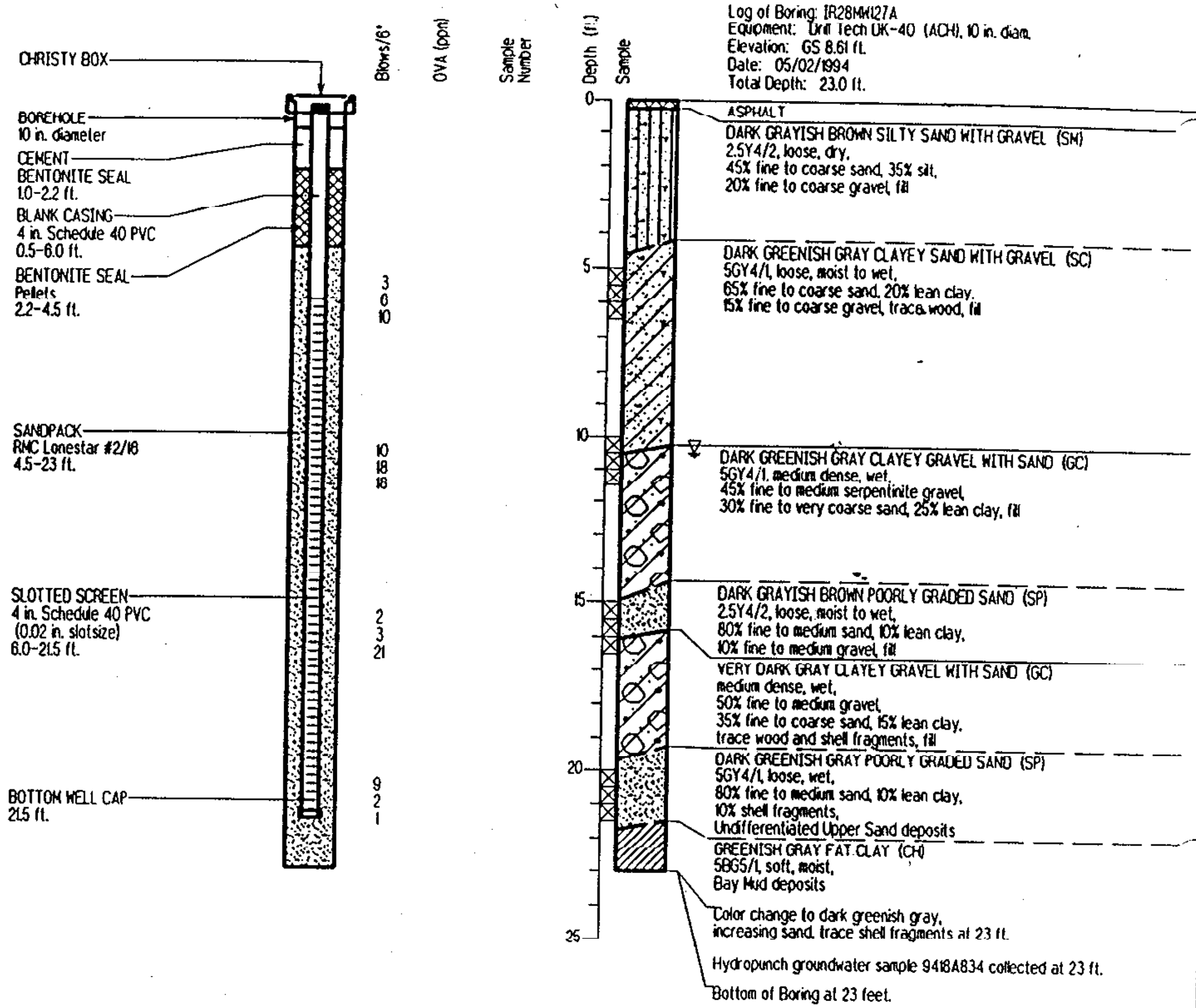
Log of Boring and Well Completion IR28MW128A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	

Log of Boring: IR28MW127A
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation: GS 8.61 ft.
Date: 05/02/1994
Total Depth: 23.0 ft.



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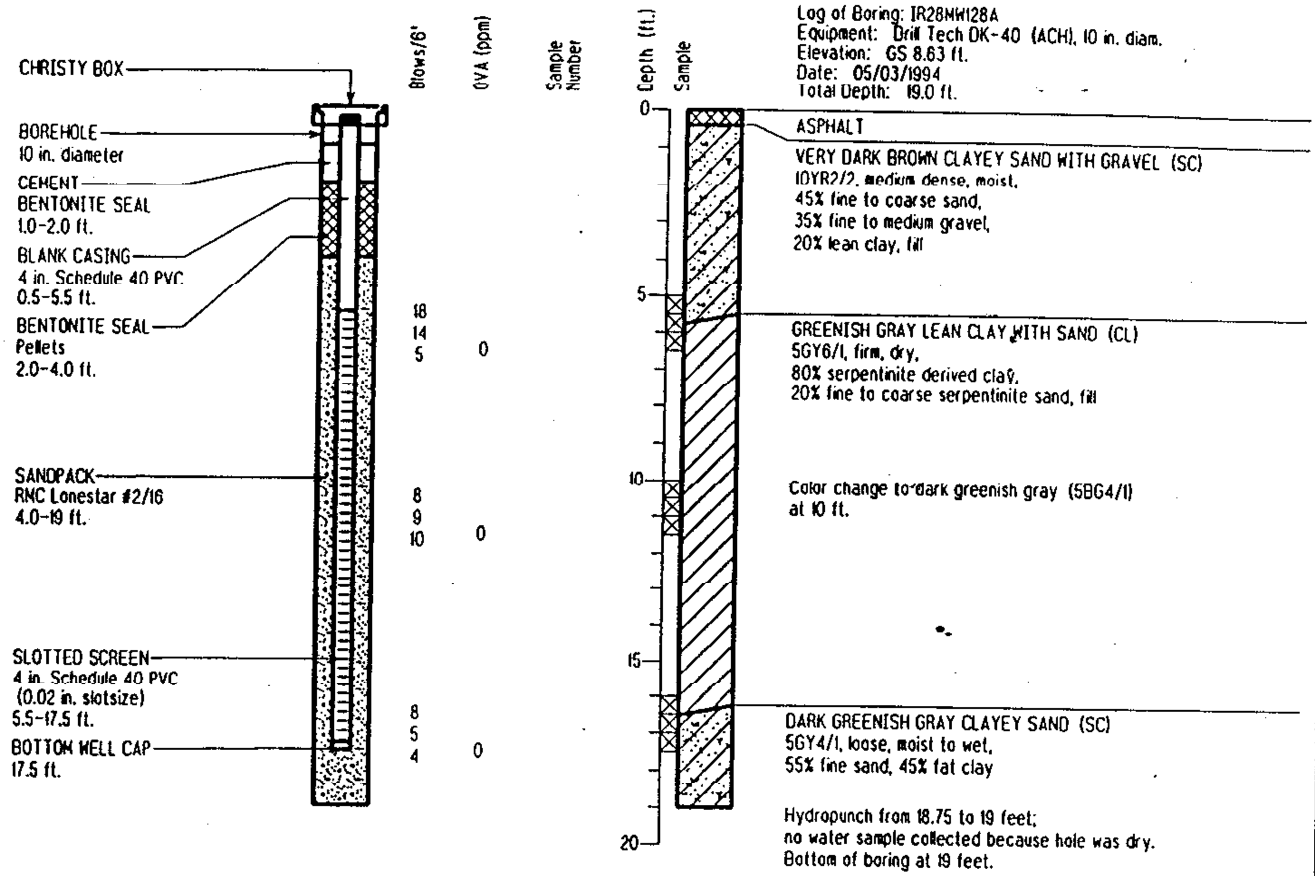
Log of Boring and Well Completion IR28MW127A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	



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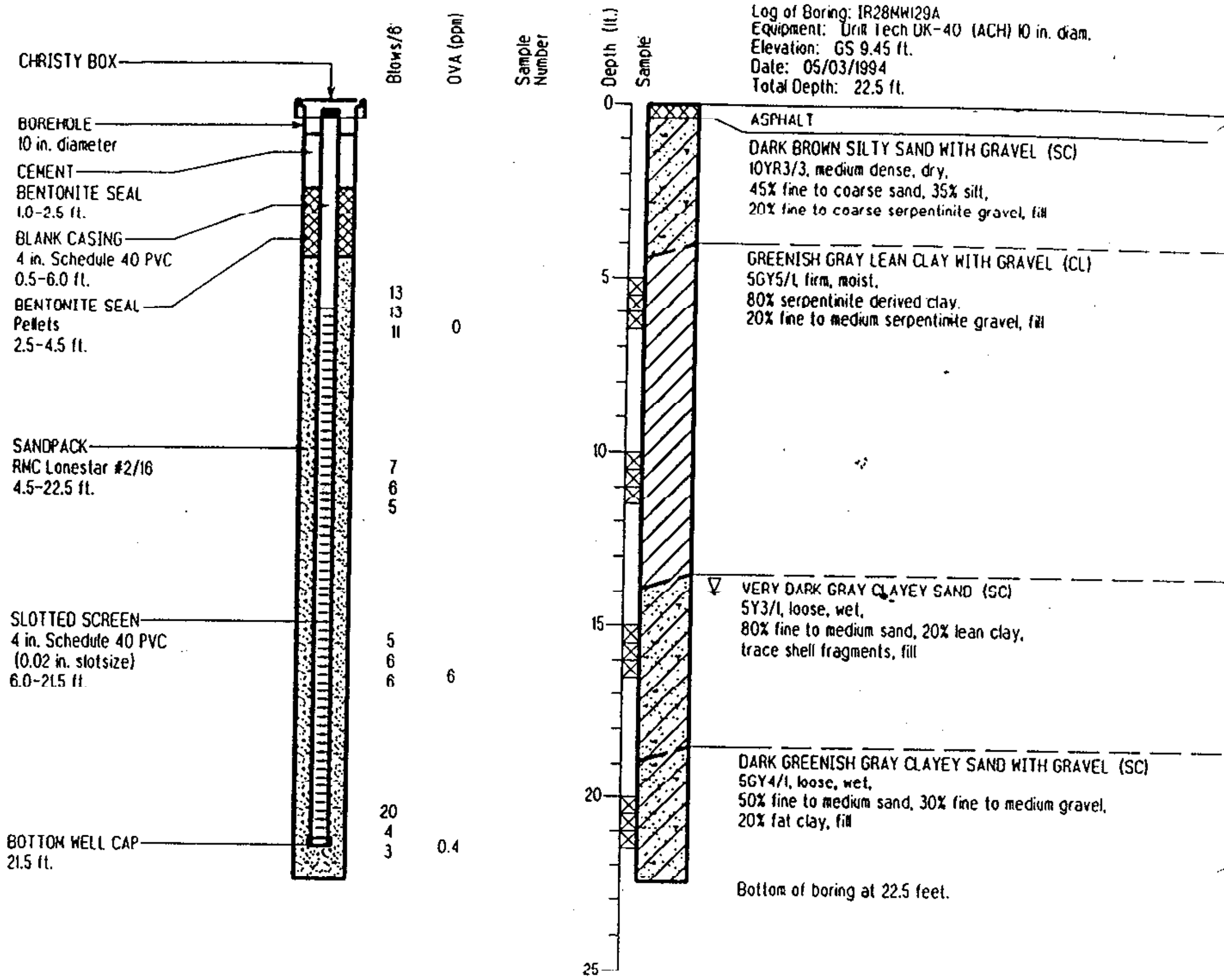
Engineering and Environmental Services

Log of Boring and Well Completion IR28MW128A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	



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Environmental Services

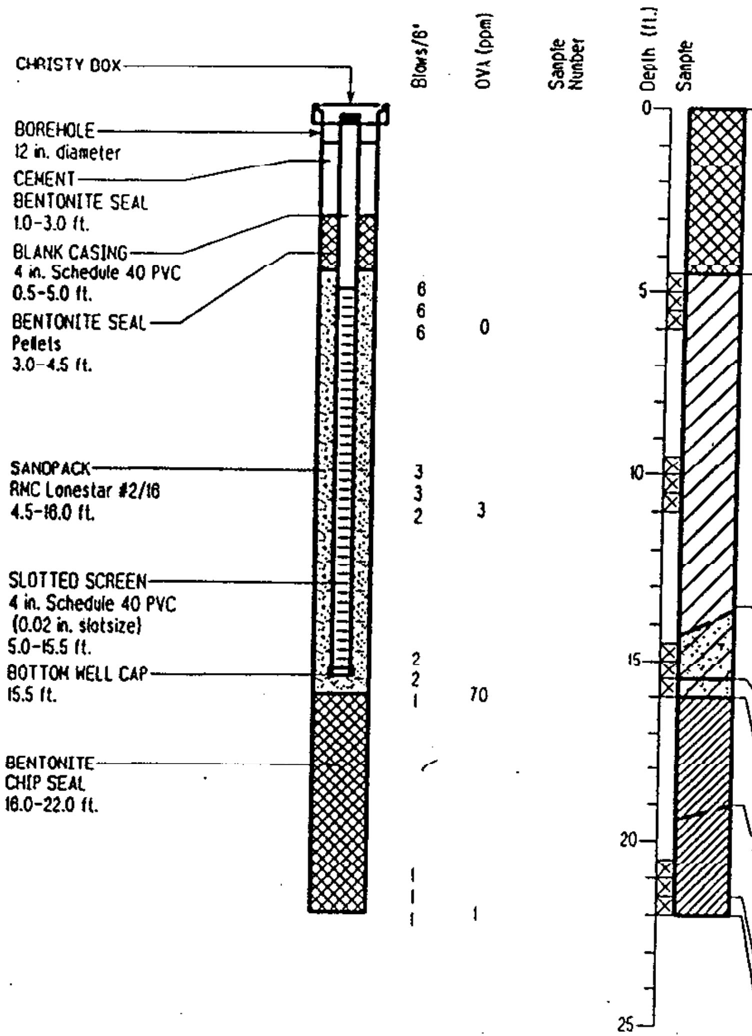
Log of Boring and Well Completion IR28MW129A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	

Log of Boring: IR28MW138A
Equipment: CME 85, (HSA) 12 in. diam.
Elevation: GS 8.01 ft.
Date: 5/24/1994
Total Depth: 22 ft.



CONCRETE

DARK GREENISH GRAY LEAN CLAY WITH GRAVEL (CL)
5GY4/1, soft, moist,
85% serpentinite derived clay,
15% fine to coarse serpentinite gravel,
fill

Sample is wet at 10 ft.

DARK GREENISH GRAY-CLAYEY SAND WITH GRAVEL (SC)
5GY4/1, loose, wet,
45% fine to very coarse sand,
30% fine to coarse gravel,
25% lean clay, fill

BLACK CLAYEY SAND (SC)
loose, moist to wet,
60% fine to medium sand, 35% lean clay,
5% shell fragments,
Undifferentiated Upper Sand deposits

DARK GREENISH GRAY FAT CLAY (CH)
5GY4/1, soft, moist,
90% clay, 5% fine to medium sand,
5% shell fragments, Bay Mud deposits

DARK GREENISH GRAY SANDY FAT CLAY (CH)
5GY4/1, soft, moist,
75% clay, 25% fine sand, trace shell fragments,
Bay Mud deposits

1.5-inch-thick layer of fine chert and serpentinite gravel at 21.5 ft.

Bottom of boring at 22 feet. Boring backfilled with bentonite chips to 16 feet.

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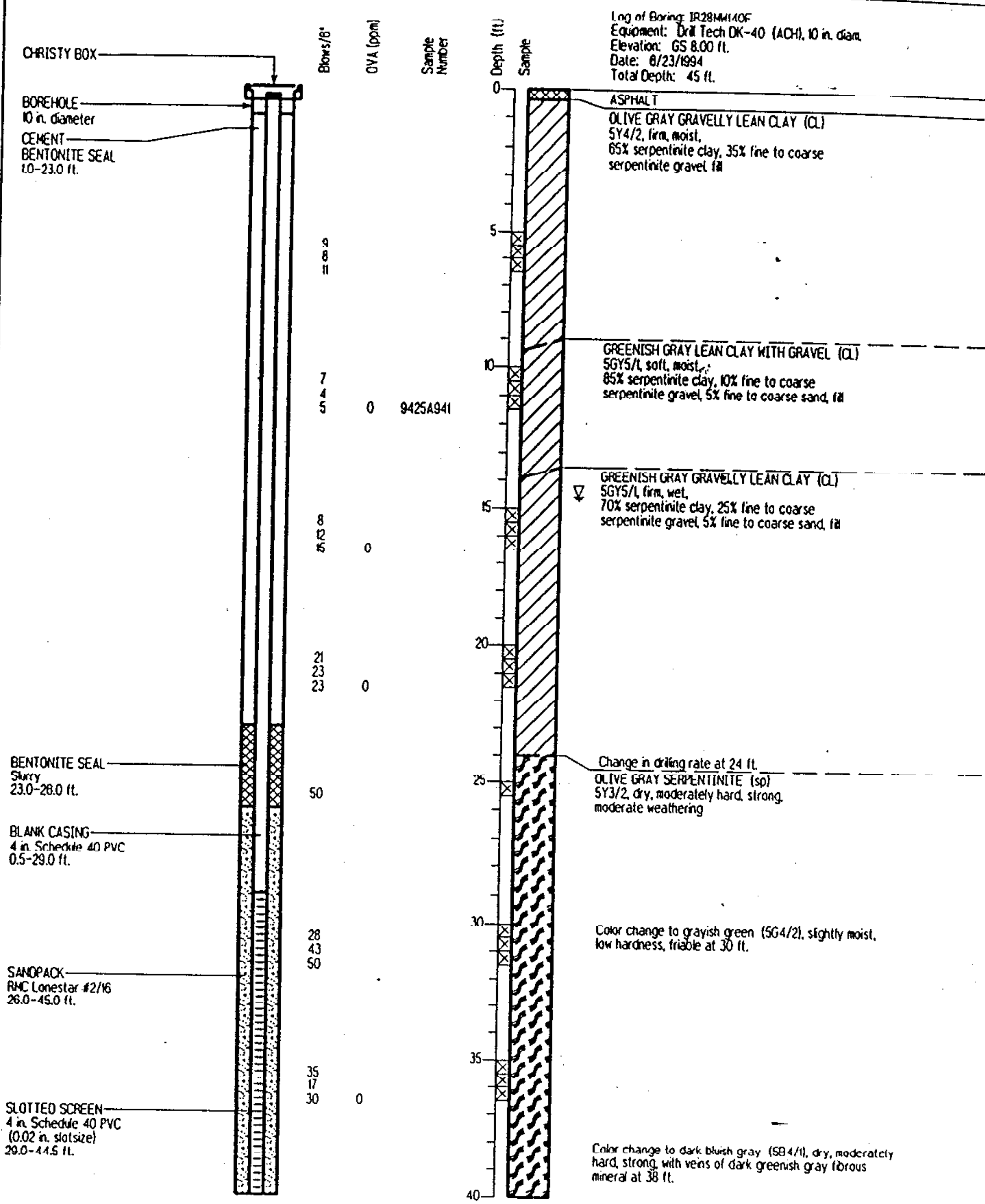
Log of Boring and Well Completion IR28MW138A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	



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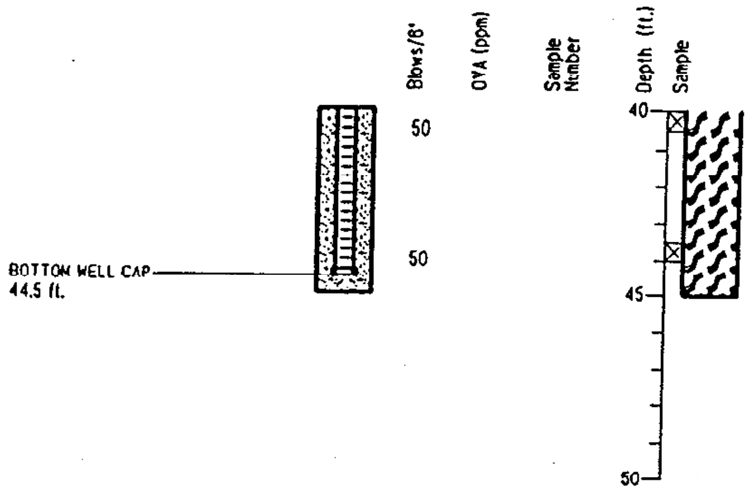
Engineering and Environmental Services

Log of Boring and Well Completion IR28MW140F
Parcel C Site Inspection Report
Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 1410		06/94	

Log of Boring: IR28MW140F
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation: GS 8.00 ft.
Date: 6/23/1994
Total Depth: 45 ft.



Bottom of boring at 45 feet.

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Log of Boring and Well Completion IR28MW140F
Parcel C Site Inspection Report
Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

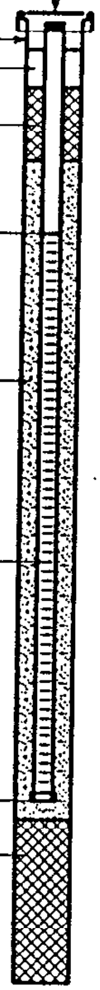
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 1410		08/94	

PLATE

Log of Boring: IR28MW149A
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation: GS 9.61 ft.
Date: 5/5/1994
Total Depth: 26.5 ft.

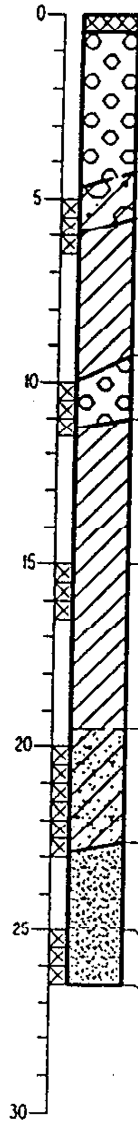
Well Construction

- CHRISTY BOX
- BOREHOLE 10 in. diameter
- CEMENT
- BENTONITE SEAL 1.0-2.0 ft.
- BENTONITE SEAL Pellets 2.0-4.0 ft.
- BLANK CASING 4 in. Schedule 40 PVC 0.5- 6.0 ft.
- SANDPACK RMC Lonestar #2/16 4.0-22.0 ft.
- SLOTTED SCREEN 4 in. Schedule 40 PVC (0.02 in. slotsize) 6.0-21.5 ft.
- BOTTOM WELL CAP 21.5 ft.
- BENTONITE CHIP SEAL 22.0-26.5 ft.



Blows/6"	OVA (ppm)	Sample Number
10		
10, 11, 5	0	
23, 11, 11	0	
11, 7, 11	0	
4, 3, 3, 3, 3, 3	0	
3, 5, 5	0	

Depth (ft.) | Sample



ASPHALT

DARK GRAY POORLY GRADED GRAVEL (GP)
N4/, loose, moist,
95% fine to medium gravel, 5% lean clay, fill

DARK GRAY CLAYEY GRAVEL (GC)
N4/, medium dense, moist,
80% fine to coarse serpentinite gravel,
15% lean clay, 5% fine to coarse serpentinite sand, fill

OLIVE GRAY GRAVELLY LEAN CLAY (CL)
5Y4/2, firm, dry,
70% serpentinite derived clay,
30% fine to coarse gravel, fill

VERY DARK GRAY POORLY GRADED GRAVEL (GP)
5Y3/1, medium dense, wet,
80% fine to coarse gravel, 10% lean clay,
10% fine to coarse sand, fill

OLIVE GRAY SANDY LEAN CLAY WITH GRAVEL (CL)
5Y5/2, firm, moist,
45% clay, 30% fine to coarse serpentinite sand,
25% fine to coarse serpentinite gravel,
fill

Color change to dark gray (5Y4/1) at 15 ft.

DARK GREENISH GRAY CLAYEY SAND (SC)
5GY4/1, loose, wet,
80% fine to medium sand, 15% fat clay,
5% shell fragments, Undifferentiated Upper Sand deposits

DARK GREENISH GRAY POORLY GRADED SAND (SP)
5GY4/1, loose, wet,
90% fine to medium sand, 5% lean clay,
5% shell fragments, Undifferentiated Upper Sand deposits

10% shell fragments at 25 ft.

Bottom of boring at 26.5 feet. Boring backfilled to 22 feet with bentonite chips.

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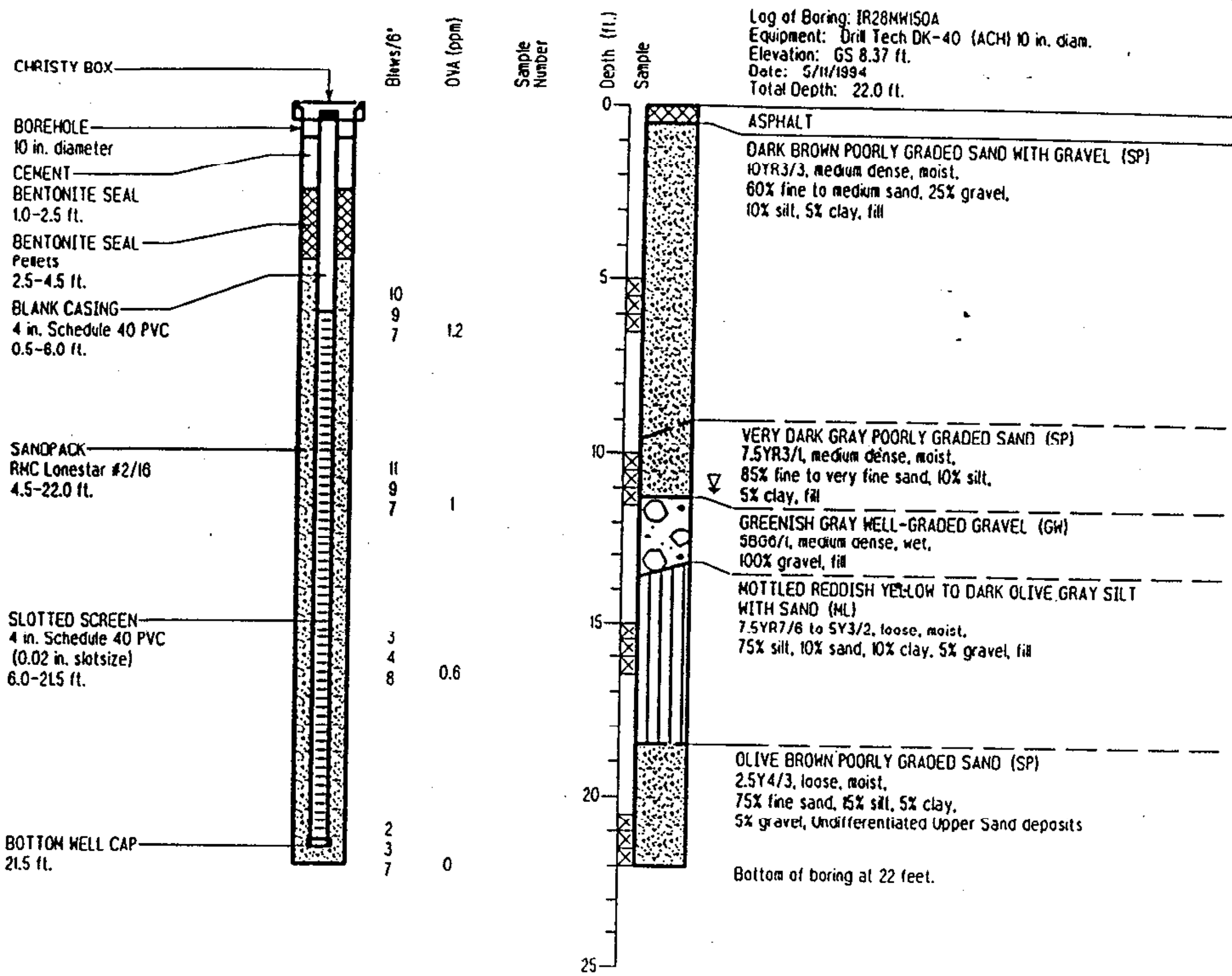
Engineering and Environmental Services

Log of Boring and Well Completion IR28MW149A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	



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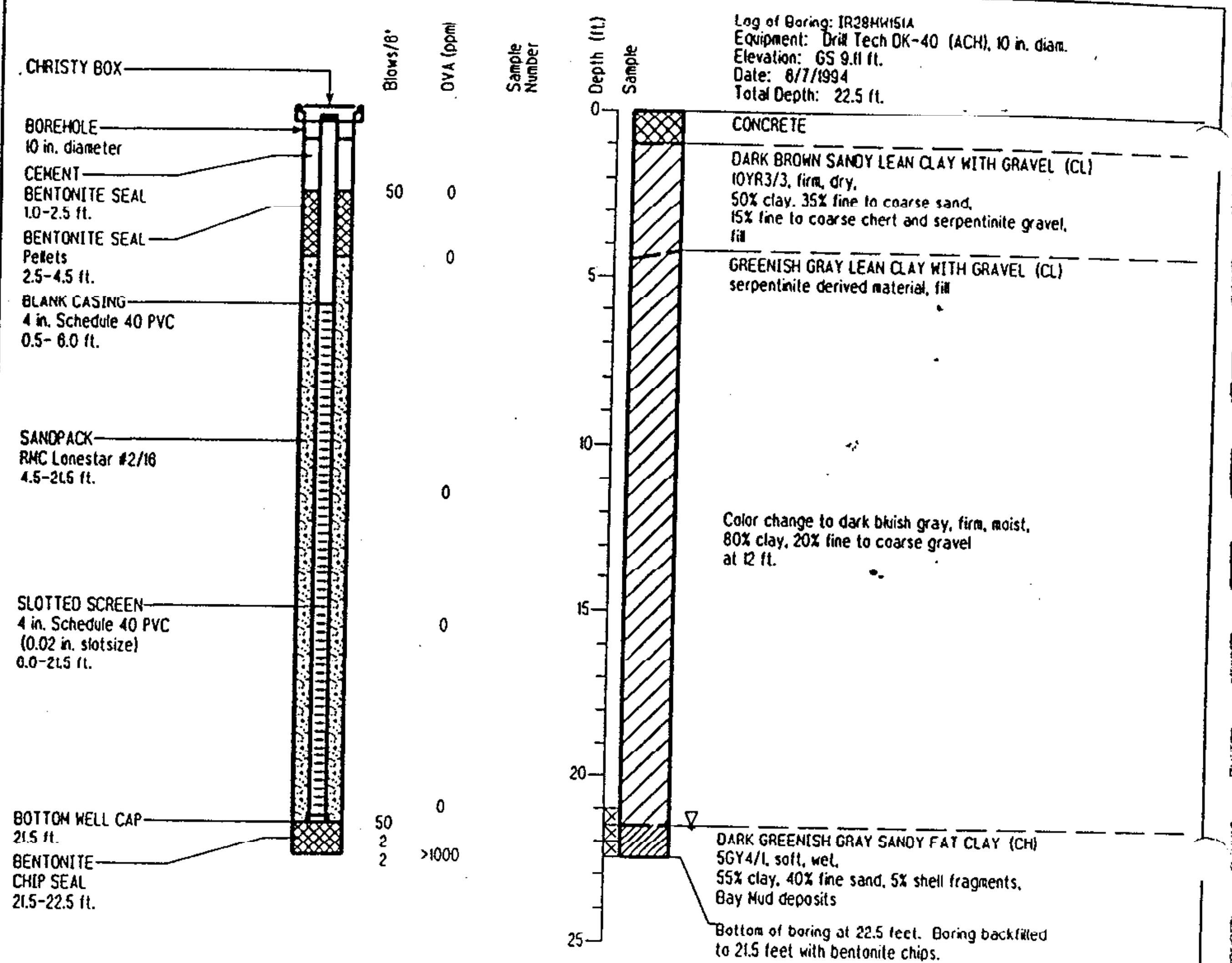
Engineering and Environmental Services

Log of Boring and Well Completion IR28MW150A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	



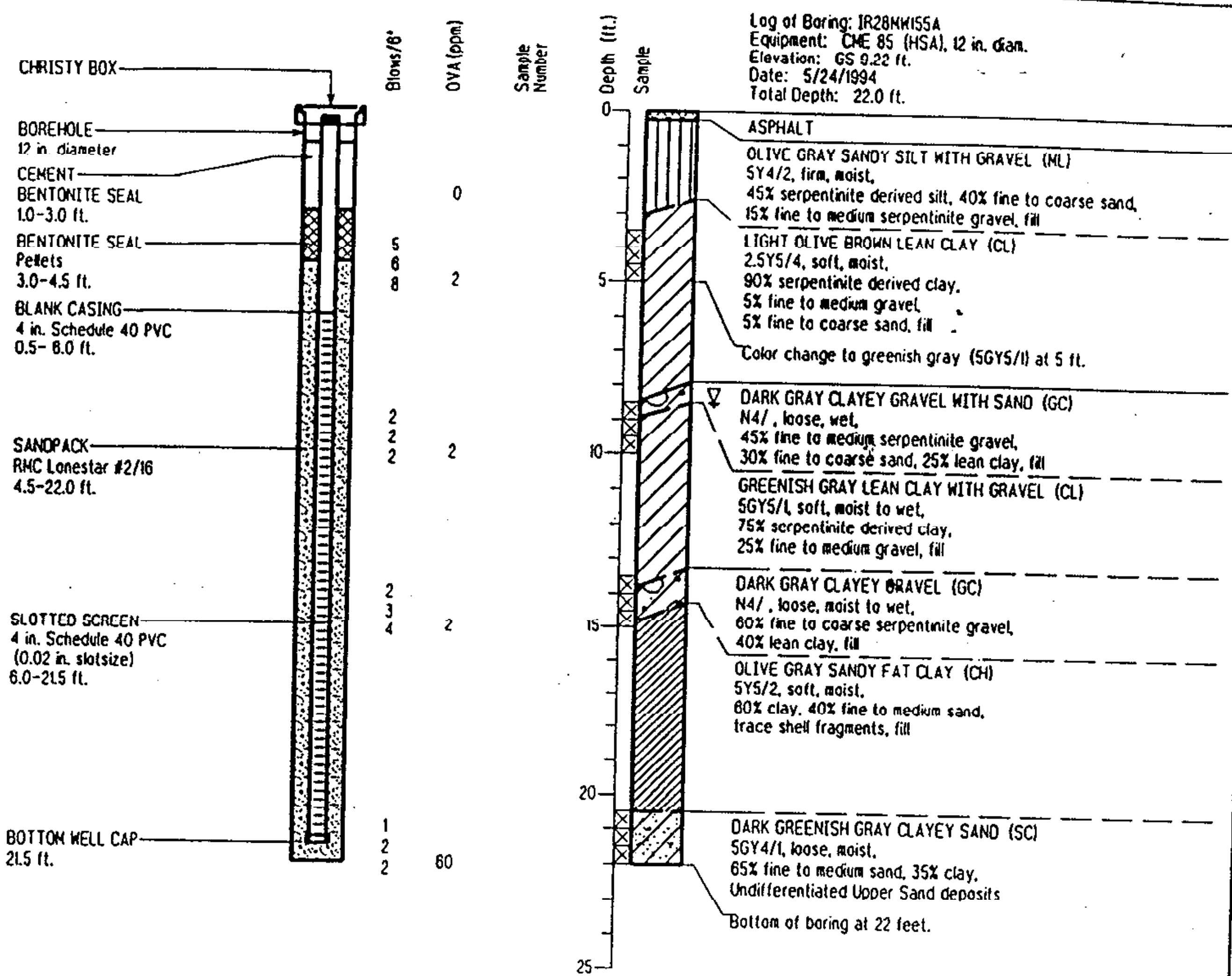
Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR28MW151A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	



Harding Lawson Associates
Engineering and Environmental Services

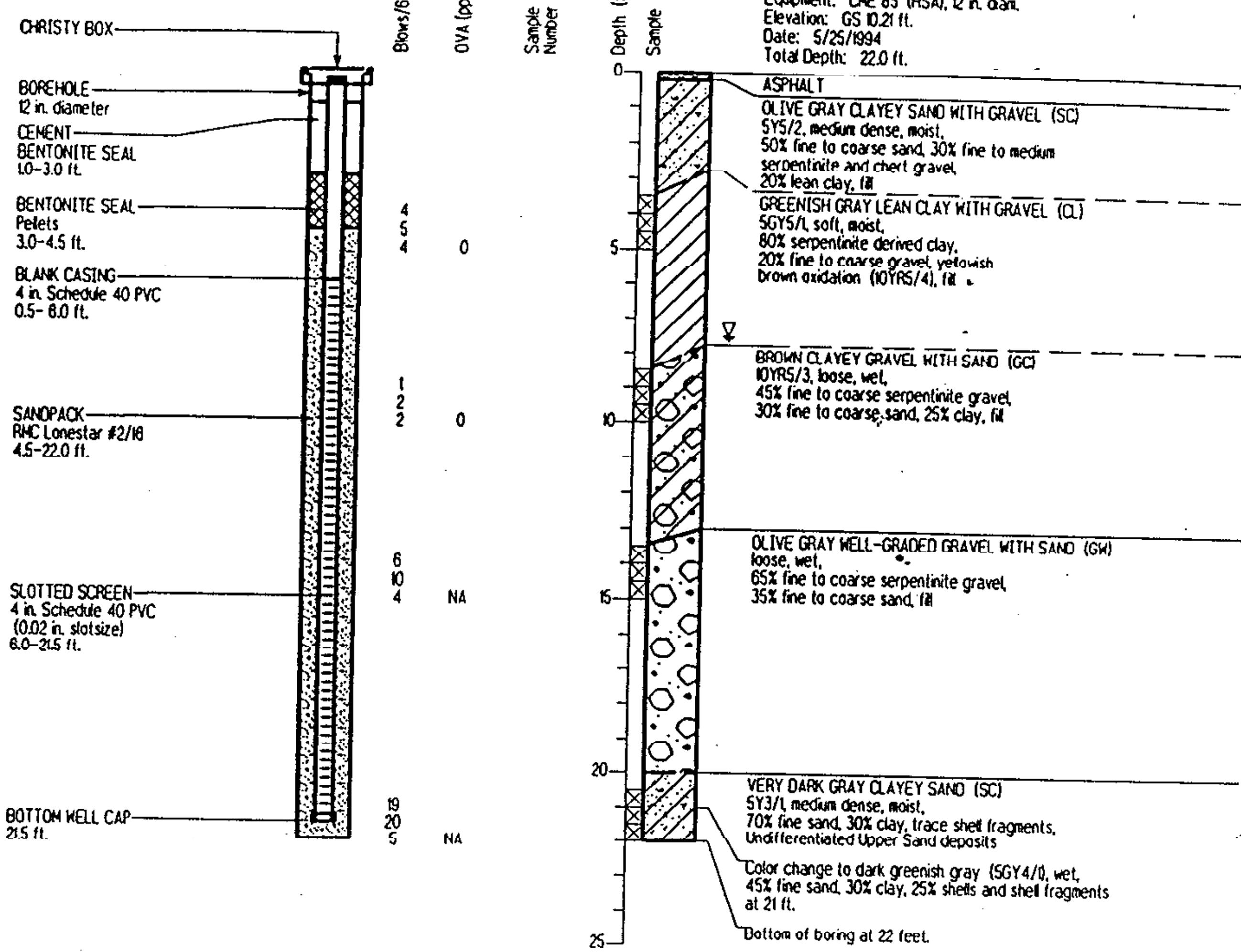
Log of Boring and Well Completion IR28MW155A

PLATE

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	

Log of Boring: IR28MW169A
Equipment: CME 85 (HSA), 12 in. diam.
Elevation: GS 10.21 ft.
Date: 5/25/1994
Total Depth: 22.0 ft.



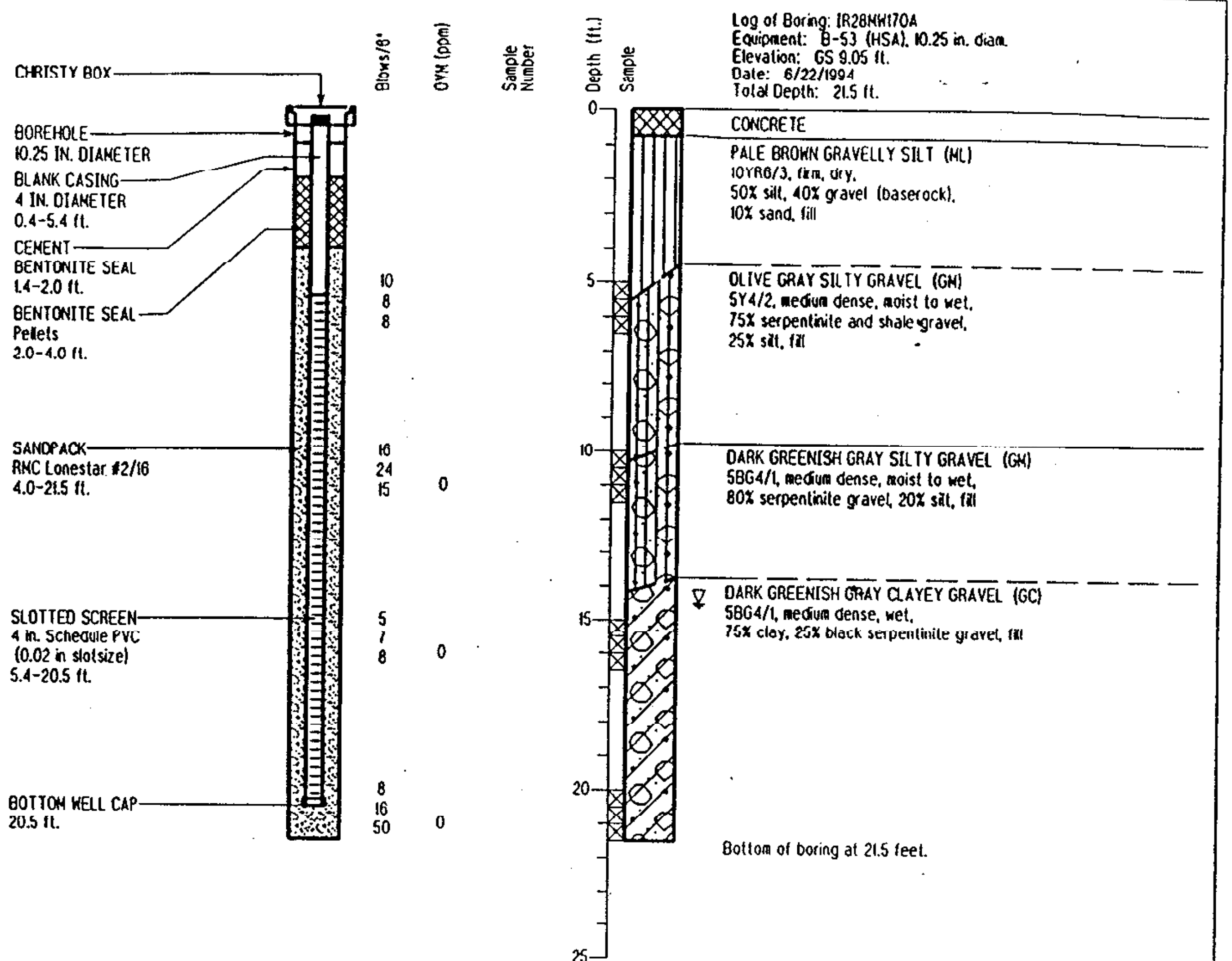
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR28MW169A

PLATE

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	



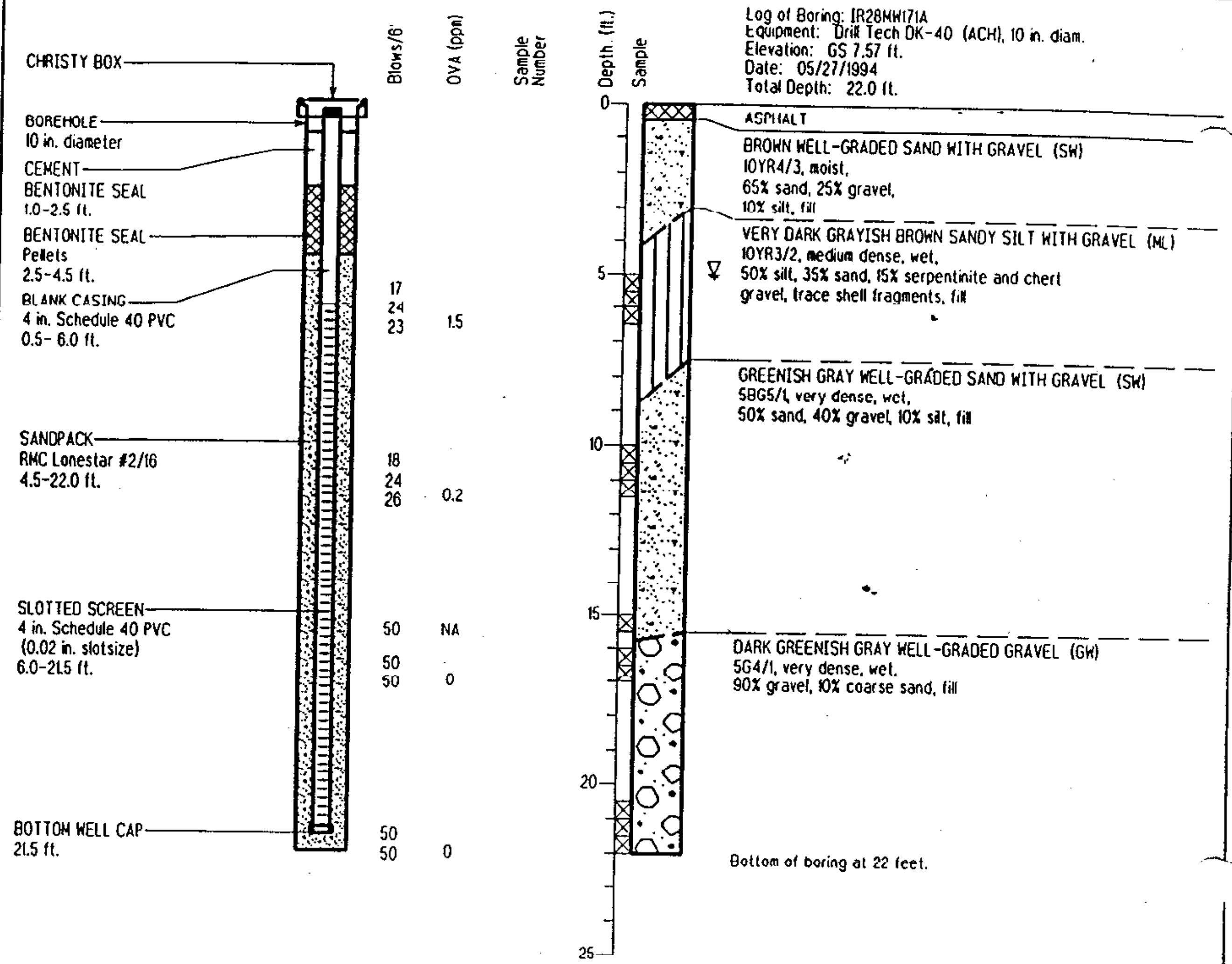
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR28MW170A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
TLB	11400 1410		08/94	



Harding Lawson Associates
Engineering and
Environmental Services

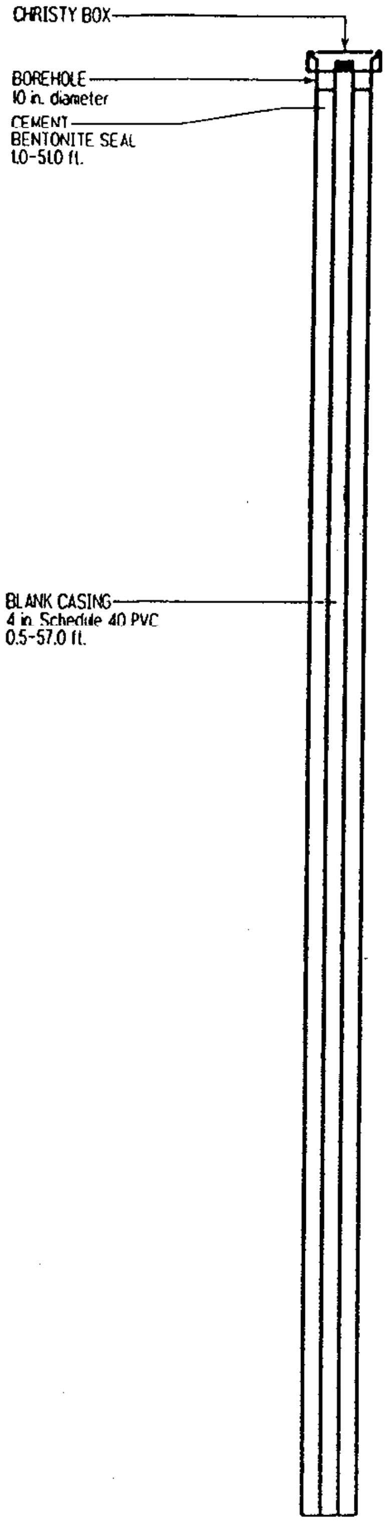
Log of Boring and Well Completion IR28MW171A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

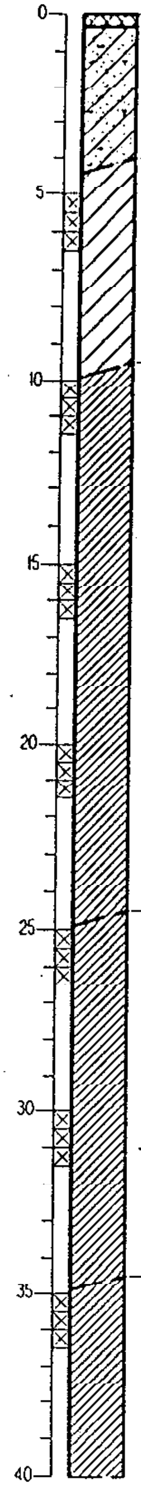
PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	

Log of Boring: IR28MW172F
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation:
Date: 11/8/1994
Total Depth: 68.0 ft.



Blows/6"	CVA (ppm)	Sample Number	Depth (ft.)
13 12 23	0		5–6.5
4 5 6			10–11.5
3 4 5	0		15–16.5
6 5 14	0		20–21.5
5 14 28	0		25–26.5
6 10 30	0		30–31.5
3 6 50	0		35–36.5



ASPHALT

VERY DARK GRAYISH BROWN CLAYEY SAND WITH GRAVEL (SC)
2.5Y3/2, medium dense, moist to wet,
45% fine to coarse sand, 35% lean clay,
20% fine to coarse gravel, fill

OLIVE GRAY LEAN CLAY WITH GRAVEL (CL)
5Y5/2, firm, dry,
70% clay, 20% fine to coarse chert and serpentinite gravel,
10% shell fragments, fill

DARK YELLOWISH BROWN FAT CLAY WITH SAND (CH)
10YR3/6, soft, moist,
85% clay, 15% fine sand,
Undifferentiated Sedimentary deposits

Change to dark yellowish brown (10YR4/6),
75% clay, 25% sand, iron oxide nodules at 15 ft.

DARK YELLOWISH BROWN SANDY FAT CLAY (CH)
10YR4/6, medium firm,
65% clay, 35% sand,
Undifferentiated Sedimentary deposits

Hard drilling at 34 ft.
YELLOWISH BROWN FAT CLAY (CH)
10YR5/4, firm, moist,
95% clay, 5% coarse chert gravel,
Undifferentiated Sedimentary deposits

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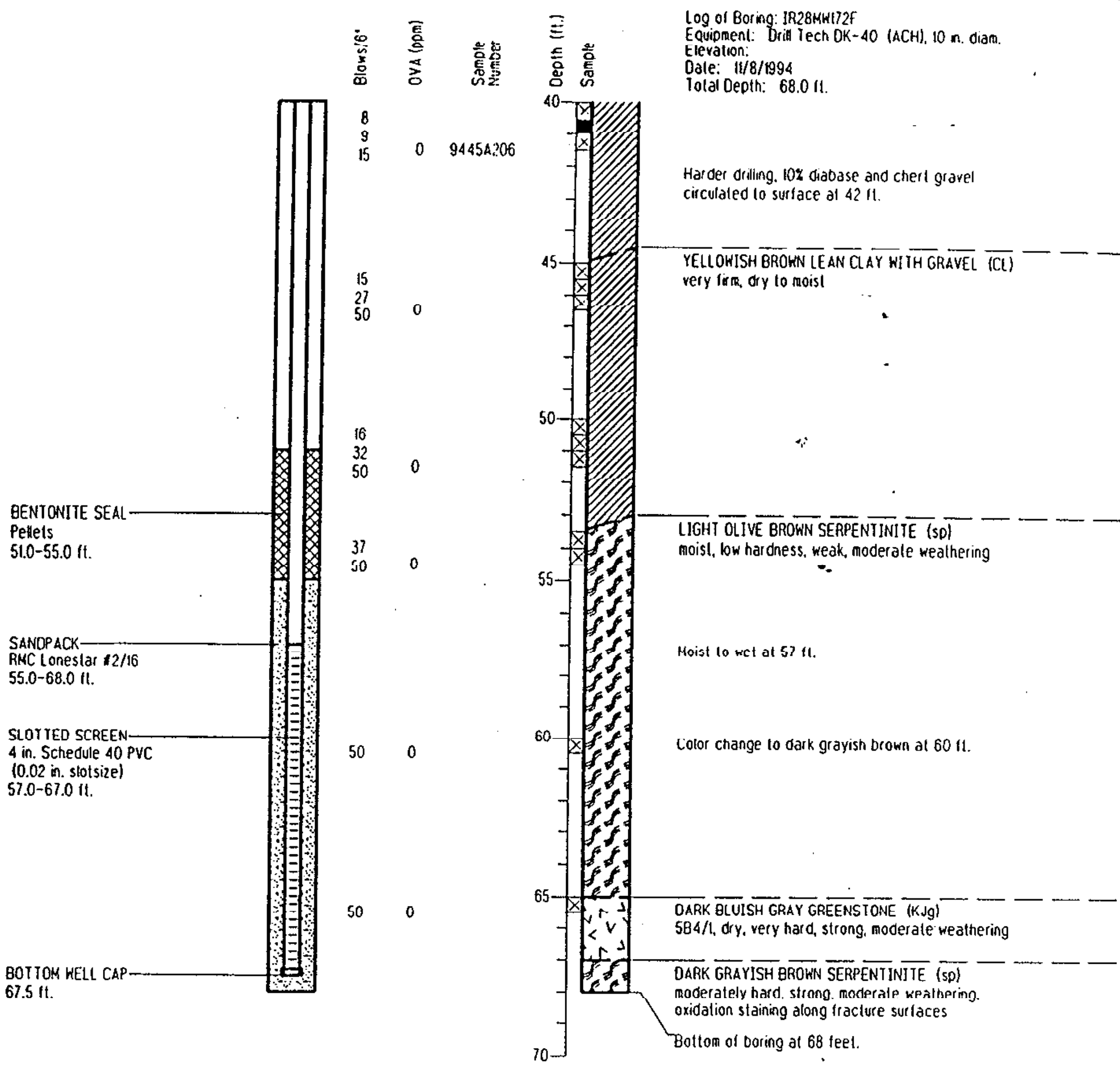
Engineering and Environmental Services

Log of Boring and Well Completion IR28MW172F

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1410		02/95	



Harding Lawson Associates
Engineering and Environmental Services

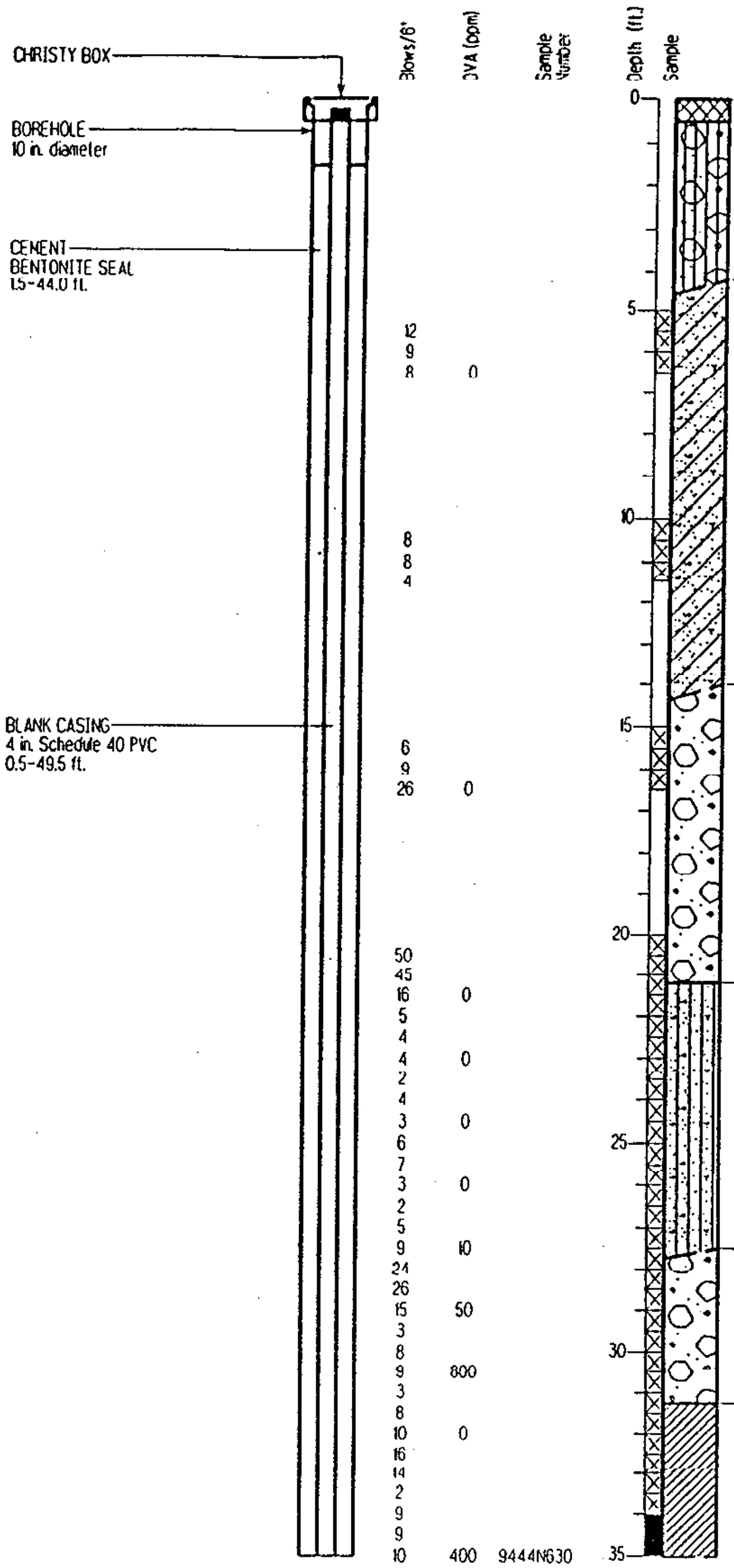
Log of Boring and Well Completion IR28MW172F

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1410		02/95	

Log of Boring: IR28MW173B
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation:
Date: 11/1/1994
Total Depth: 61.0 ft.



ASPHALT

VERY DARK GRAYISH BROWN SILTY GRAVEL (GM)
10YR3/2, loose to medium dense, dry,
50% gravel, 20% silt, 20% wood debris, 10% sand, fill

GREENISH GRAY CLAYEY SAND WITH GRAVEL (SC)
5GY6/1, loose, moist,
40% highly weathered serpentinite sand,
30% serpentinite and sandstone gravel,
30% serpentinite derived clay, fill.

Trace wood debris at 10 ft.

DARK GREENISH GRAY WELL-GRADED GRAVEL WITH SAND (GW)
5BG4/1, medium dense, wet,
50% serpentinite gravel, 40% sand,
10% serpentinite derived clay, fill

VERY DARK GRAY SILTY SAND (SM)
5Y3/1, loose, wet,
60% fine sand, 20% silt, 20% shells,
Undifferentiated Upper Sand deposits

Change to 70% sand, 10% shell fragments at 25 ft.

WELL-GRADED GRAVEL (GW)
loose, wet,
90% chert gravel to cobbles, 10% sand

OLIVE GRAY FAT CLAY (CH)
5Y4/2, firm, moist,
90% clay, 10% organic fibers,
iron oxide staining and plant molds,
Bay Mud deposits

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Environmental Services

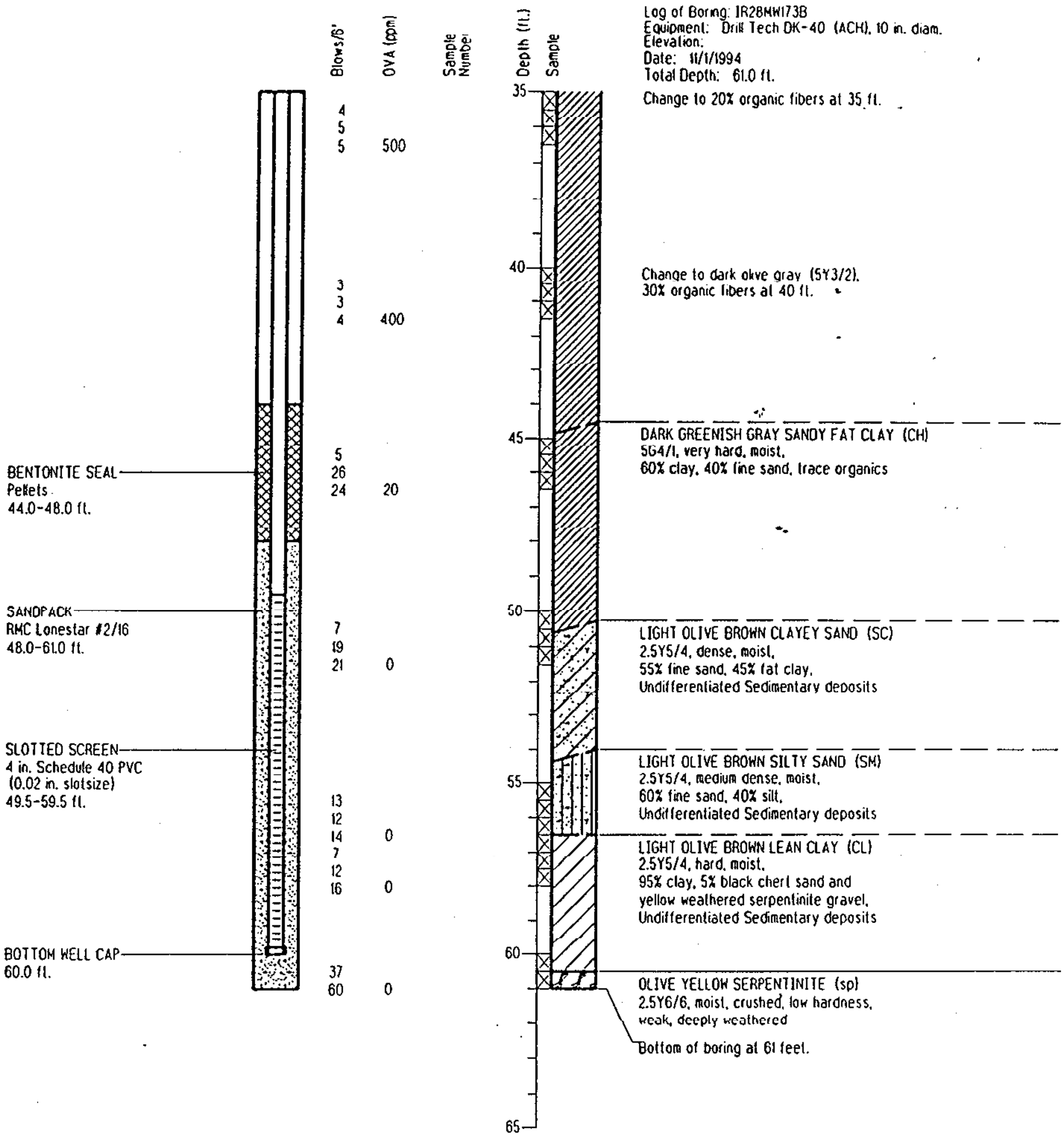
Log of Boring and Well Completion IR28MW173B

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1410		02/95	

Log of Boring: IR28MW173B
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation:
Date: 11/1/1994
Total Depth: 61.0 ft.



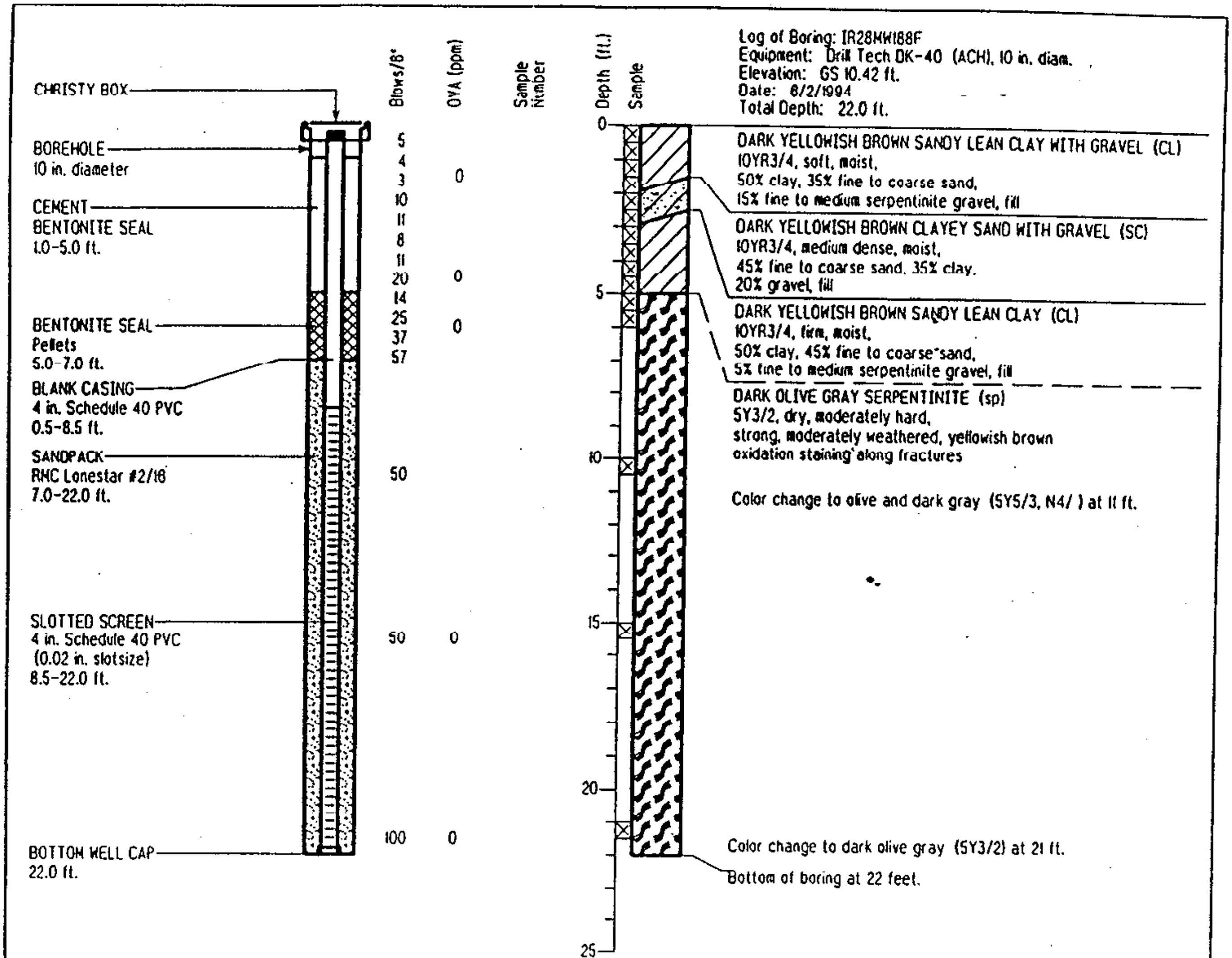
Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR28MW173B

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1410		02/95	



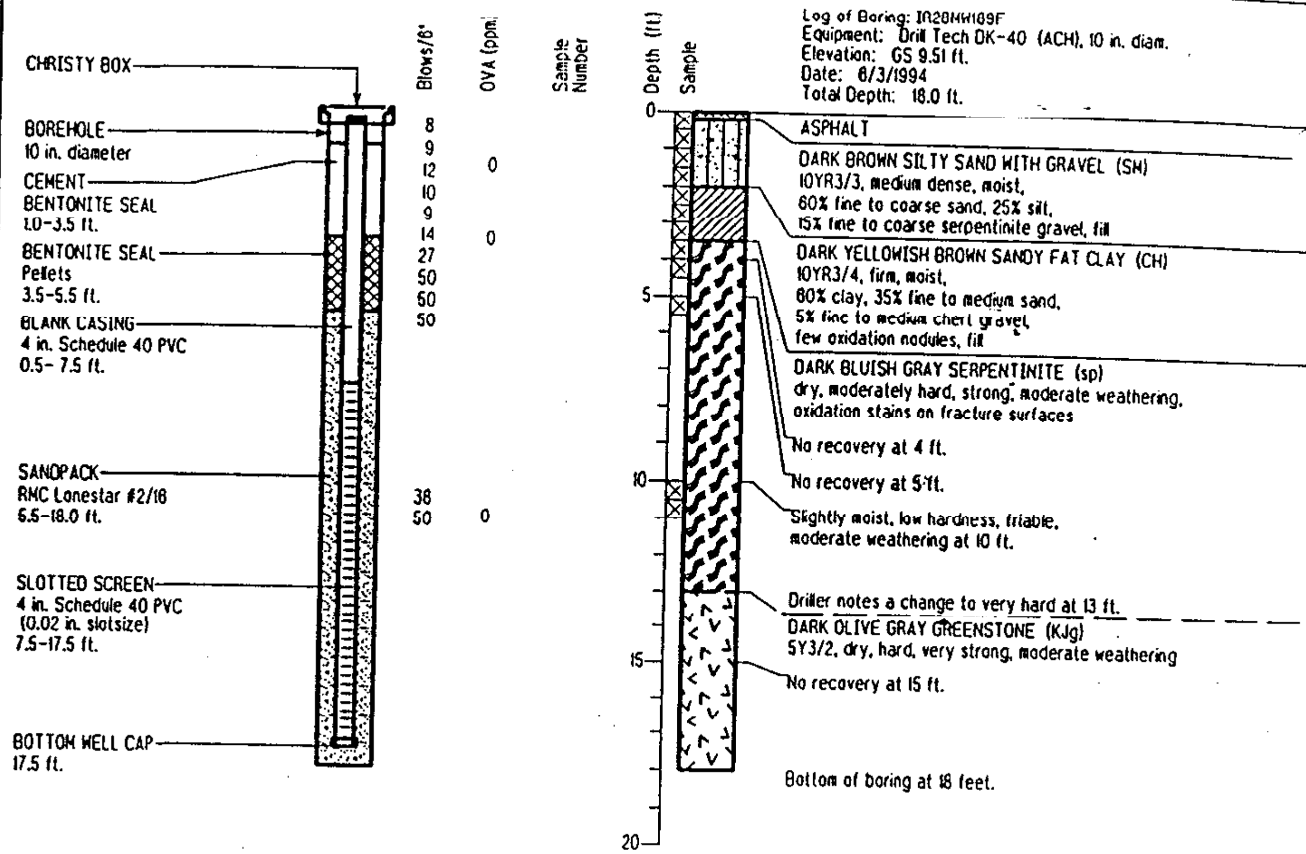
Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR28MW188F

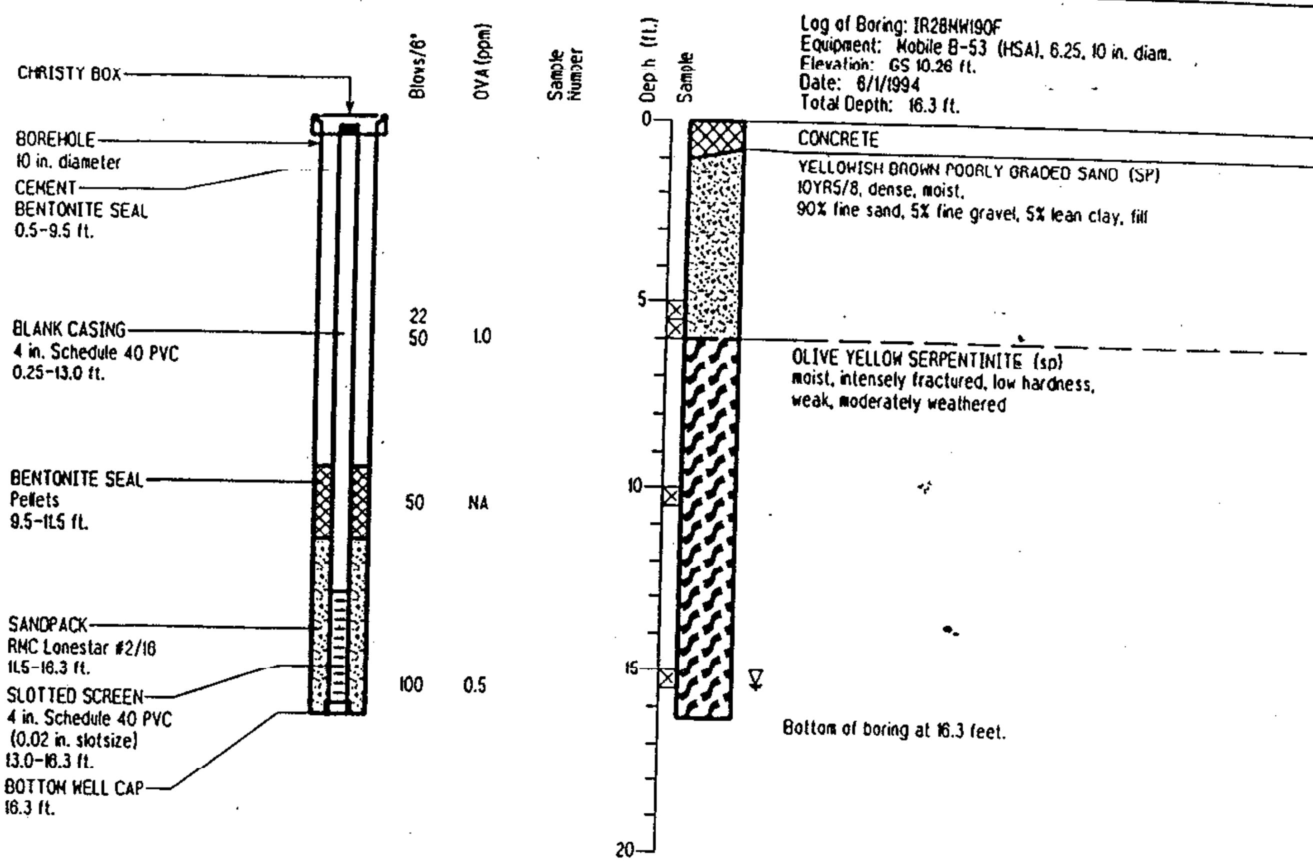
Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	



Harding Lawson Associates Engineering and Environmental Services		Log of Boring and Well Completion IR28MW189F Naval Station Treasure Island Hunters Point Annex San Francisco, California	PLATE
DRAWN KLR	JOB NUMBER 11400 1410	APPROVED	DATE 08/94	REVISED DATE



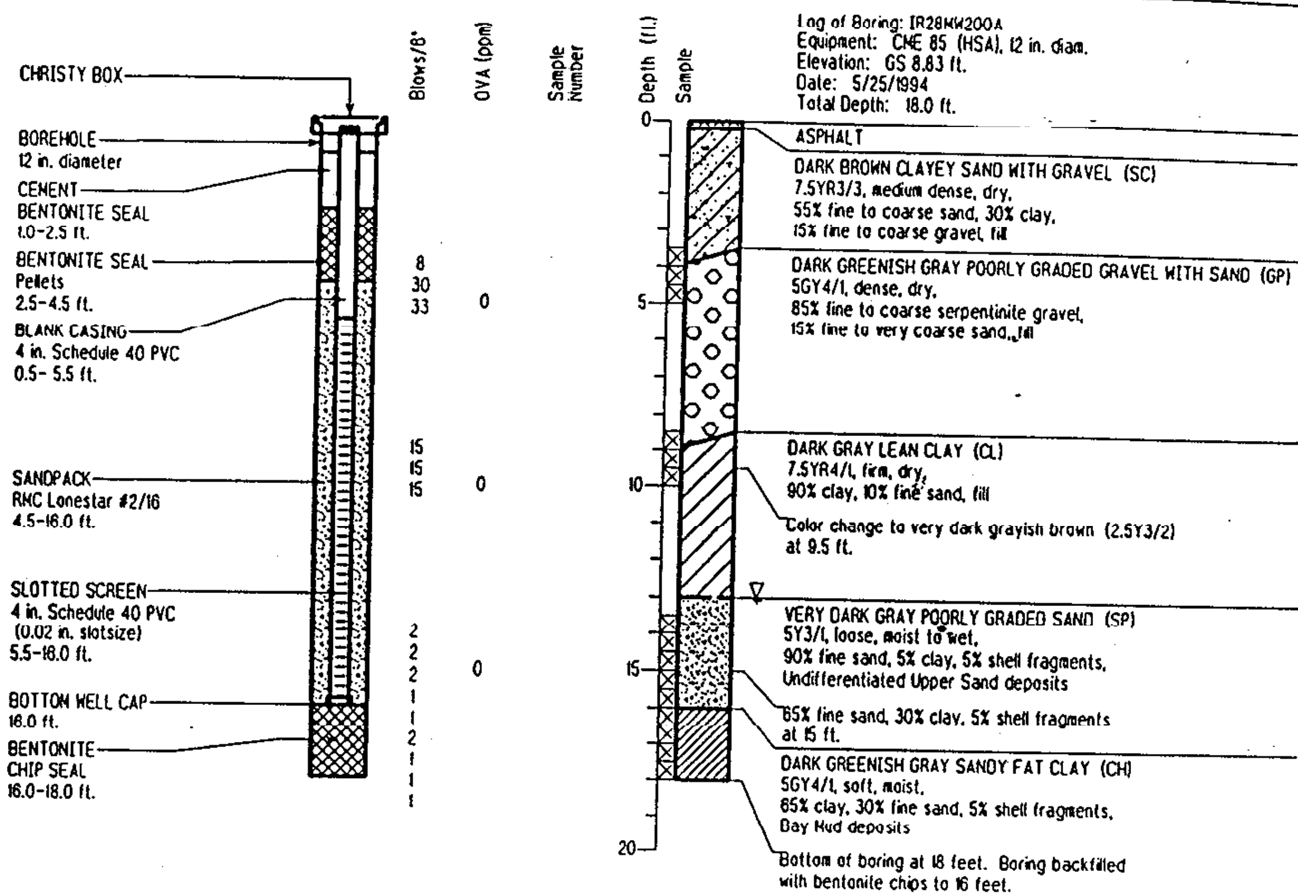
Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR28MW190F

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	



Harding Lawson Associates
Engineering and Environmental Services

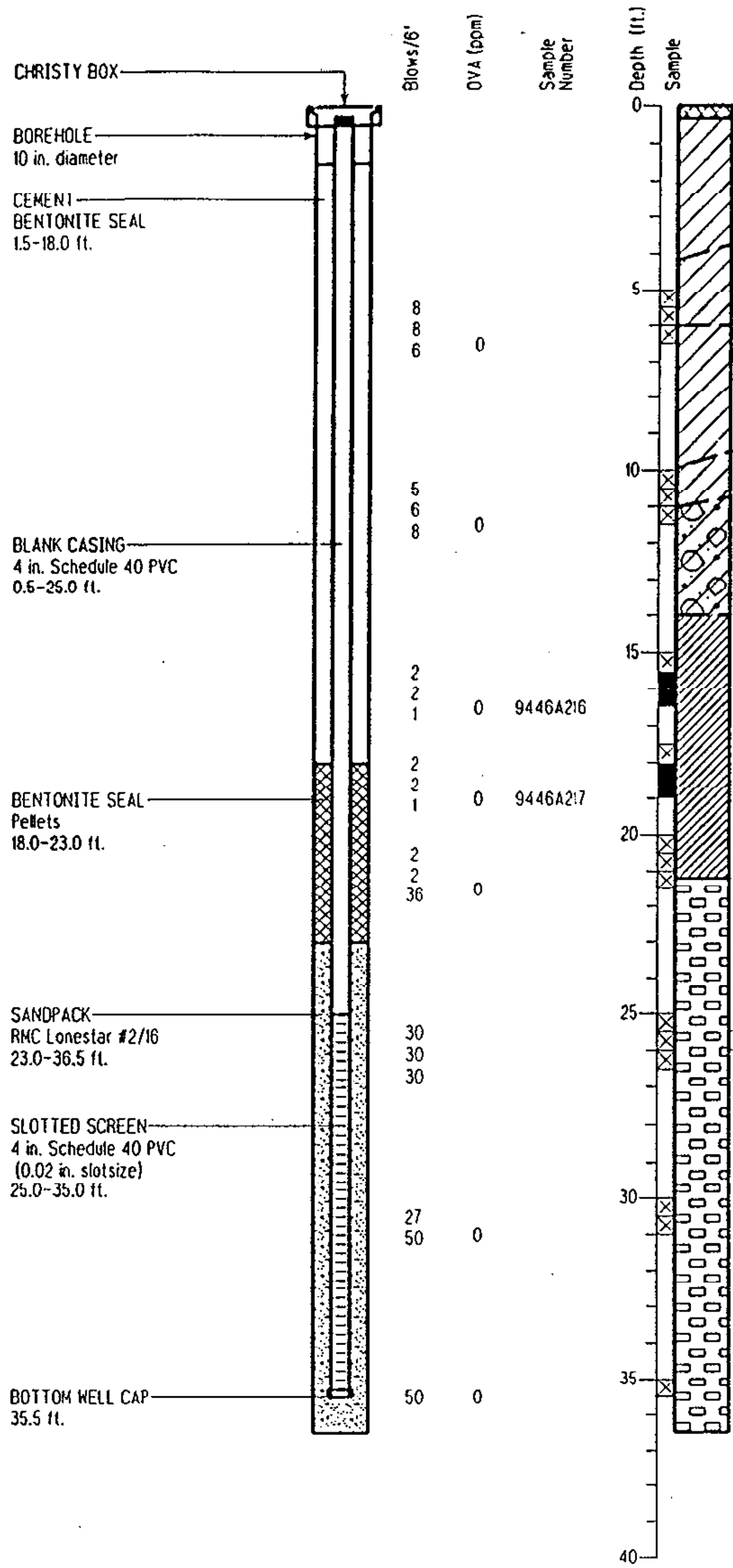
Log of Boring and Well Completion IR28MW200A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	

Log of Boring: IR28MW201F
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation:
Date: 11/17/1994
Total Depth: 36.5 ft.



ASPHALT

DARK YELLOWISH BROWN GRAVELLY LEAN CLAY (CL)
10YR3/4, firm, moist,
70% clay, 30% fine gravel, fill

DARK YELLOWISH BROWN LEAN CLAY WITH GRAVEL (CL)
10YR3/4, firm, moist,
80% serpentinite derived clay,
20% serpentinite and chert gravel, fill

BLACK LEAN CLAY (CL)
2.5Y2.5/1, firm, moist,
95% serpentinite derived clay,
5% fine serpentinite gravel, fill

DARK YELLOWISH BROWN LEAN CLAY WITH GRAVEL (CL)
10YR3/6, firm, moist,
75% clay, 25% fine serpentinite and chert gravel, fill

STRONG BROWN CLAYEY GRAVEL WITH SAND (GC)
dense, wet,
60% fine to coarse gravel, 25% clay, 15% sand, fill

DARK GREENISH GRAY SANDY FAT CLAY (CH)
5G4/1, soft, wet,
55% clay, 35% medium sand, 10% shell fragments,
Bay Mud deposits

Change to trace shell fragments at 20 ft.

DARK RED CHERT (KJc)
10R3/6, wet, hard, strong, little weathering

Highly weathered to soil-like at 25 ft.

Change to olive yellow (2.5Y6/6), wet,
intensely to closely fractured, hard,
moderately strong, moderately weathered at 25.5 ft.

Highly weathered to soil-like at 26 ft.

Change to very dusky red (2.5YR2.5/4), low hardness,
weak, deep weathering, altering to soil-like at 30 ft.

Hard, strong at 33 ft.

Change to dark reddish brown (5YR3/4), dry at 35 ft.

Bottom of boring at 36.5 feet.

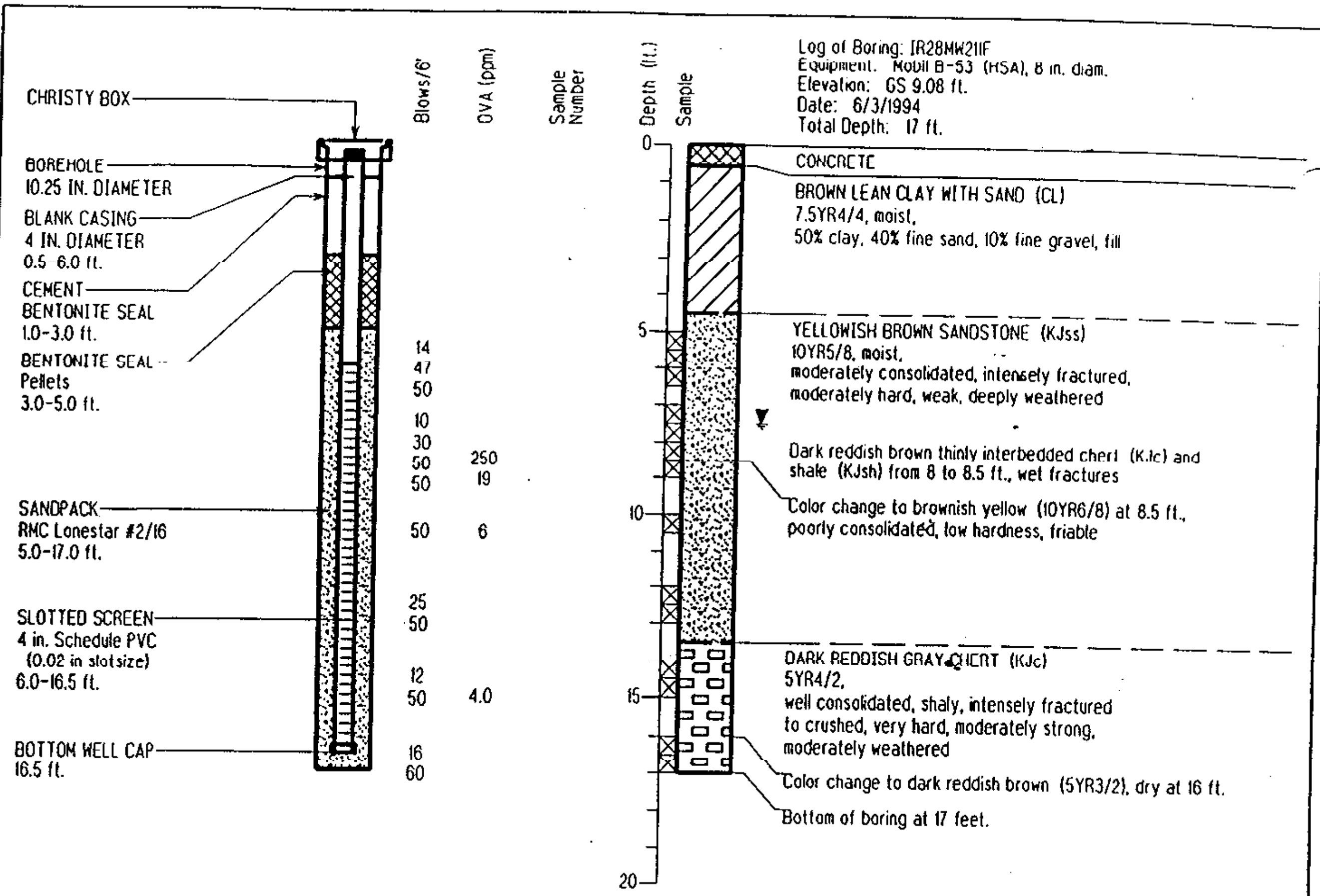
Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR28MW201F

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1410		02/05	



Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR28MW211F

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
TLB	11400 1410		08/94	

Log of Boring: IR28MW216F
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation: GS 9.08 ft.
Date: 06/06/1994
Total Depth: 30.5 ft.

CHRISTY BOX

BOREHOLE
10 in. diameter

CEMENT BENTONITE SEAL
1.0-13.0 ft.

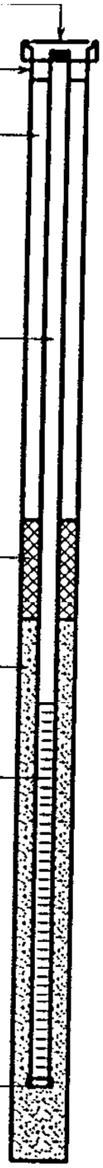
BLANK CASING
4 in. Schedule 40 PVC
0.5-18.0 ft.

BENTONITE SEAL
Pellets
13.0-15.7 ft.

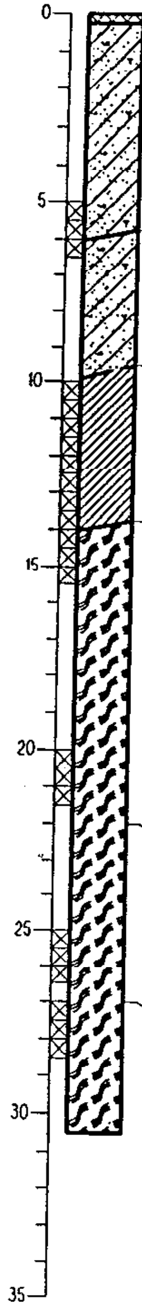
SANDPACK
RMC Lonestar #2/16
15.7-30.5 ft.

SLOTTED SCREEN
4 in. Schedule 40 PVC
(0.02 in. slotsize)
18.0-28.5 ft.

BOTTOM WELL CAP
28.5 ft.



Blows/6"	OVA (ppm)	Sample Number	Depth (ft.)
30 11 8	0		5
6 6 6 6 8 7 8 8 12 14 15			10–15
7 20 42	0		20
27 28 30	0		25
19 22 27	0		



ASPHALT

OLIVE GRAY CLAYEY SAND WITH GRAVEL (SC)
5Y5/2, dense, moist,
65% fine to coarse serpentinite sand,
20% lean serpentinite derived clay,
15% fine to coarse serpentinite gravel, fill

DARK YELLOWISH BROWN CLAYEY SAND (SC)
10YR4/4, firm,
55% fine sand, 40% fat clay,
5% fine chert gravel, trace oxidation nodules

DARK YELLOWISH BROWN FAT CLAY (CH)
10YR4/4, soft, moist,
95% clay, 5% fine to medium chert gravel

LIGHT OLIVE BROWN-SERPENTINITE (sp)
2.5Y5/4, moist, low hardness, friable,
moderate weathering, weathered to serpentinite lean clay

Color change to very dark grayish brown (2.5Y4/2), some oxidation staining, at 21 ft.

Weathered to a lean clay at 22 ft.

Color change to olive brown (2.5Y4/4) at 25 ft.

Color change to dark olive brown at 26.5 ft.

Color change to olive brown (2.5Y4/4) at 27 ft.

Bottom of boring at 30.5 feet.

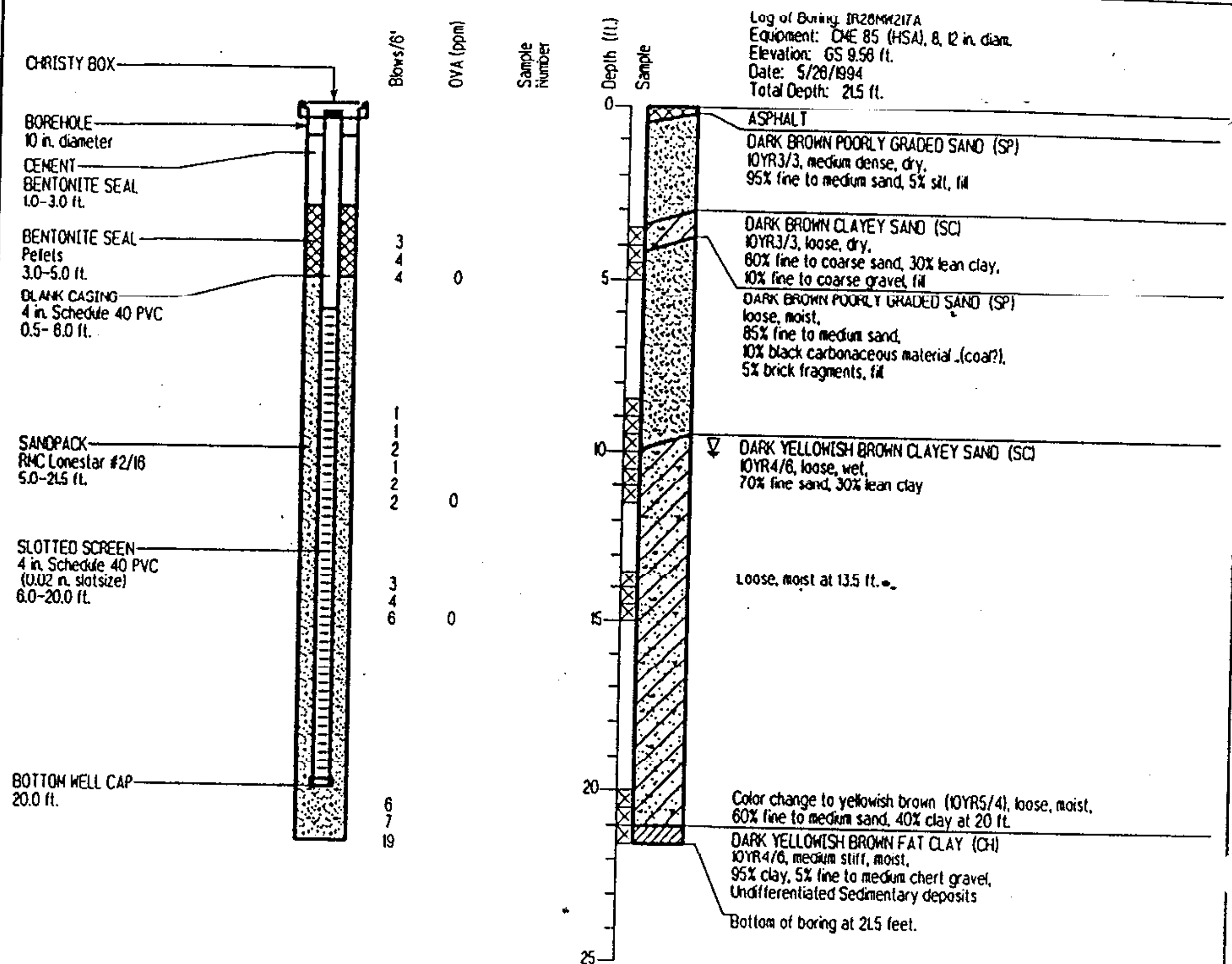
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR28MW216F

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	



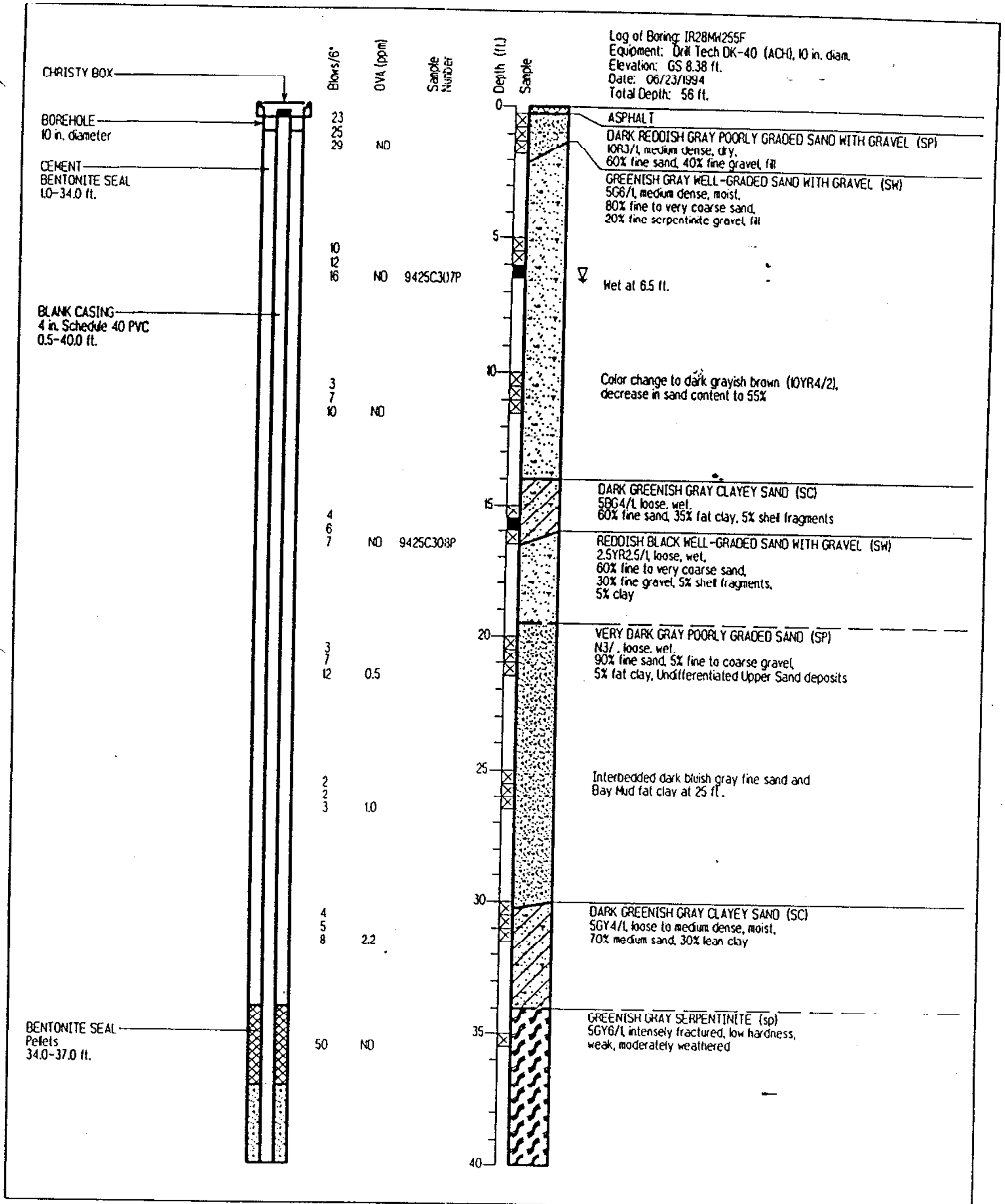
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR28MW217A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
KLR	11400 1410		08/94	



Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR28MW255F

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

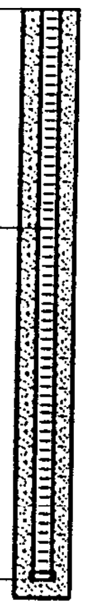
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1410		08/94	

Log of Boring: IR28MW255F
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation: GS 8.38 ft.
Date: 06/23/1994
Total Depth: 56 ft.

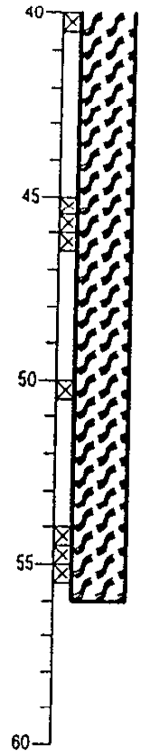
SANDPACK
RMC Lonestar #2/16
37.0-56.0 ft.

SLOTTED SCREEN
4 in. Schedule 40 PVC
(0.02 in. slotsize)
40.0-55.5 ft.

BOTTOM WELL CAP
55.5 ft.



Blows/6"	OVA (ppm)	Sample Number	Depth (ft.)	Sample	Description
50	ND		40		
32 35 42	NA		45		Friable, deeply weathered at 45 ft., some brownish yellow iron oxide staining, fractures are wet
50	ND		50		Moderately weathered at 50 ft.
30 35 40	ND		55		Deeply weathered at 54 ft.
					Bottom of borehole at 56 feet.
			60		



Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR28MW255F

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

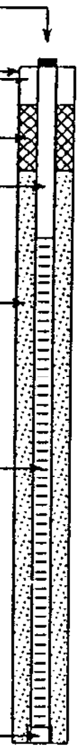
PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1410		08/94	

PRC Environmental Management, Inc.

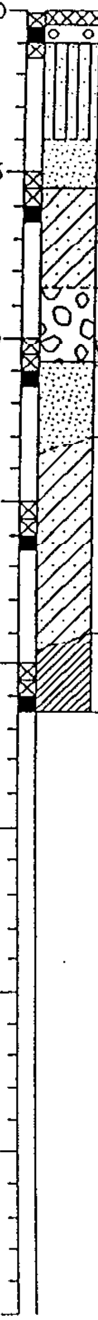
LOG OF BORING IR28MW268A

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.
11, 9, 16	0.6	9542J483
12, 4, 6	0	9542J484
31, 24, 21	0	9542J485
3, 6, 7	0	9542J486
3, 5, 7	0	9542J487

Depth (ft): 0, 5, 10, 15, 20, 25, 30, 35, 40



Materials Description

ASPHALT

REDDISH BROWN POORLY GRADED GRAVEL (GP)
5YR5/4, medium dense, dry, 90% coarse chert gravel, 10% fine sand, trace wood fragments, fill

DARK YELLOWISH BROWN SILTY SAND (SM)
10YR4/4, medium dense, moist, 70% fine to medium sand, 20% silt, 5–10% coarse, chert gravel, trace lean clay, fill

DARK BROWN POORLY GRADED SAND WITH GRAVEL (SP)
10YR3/3, medium dense, dry, 80% fine sand, 20% medium to coarse gravel, fill

DARK GREENISH GRAY CLAYEY SAND (SC)
5G4/1, medium dense, moist, 75% very fine to fine sand, 15% lean clay, 5–10% silt, trace shell fragments, fill

GRAYISH GREEN WELL-GRADED GRAVEL (GW)
5G5/2, medium dense, moist, 70% weathered serpentinite gravel, 20% wood fragments, 10% fine to medium sand, fill

OLIVE POORLY GRADED SAND (SP)
5Y5/4, medium dense, wet, 95% fine to medium sand, 5% shell fragments, undiffentiated upper sand deposits

DARK BLUISH GRAY CLAYEY SAND (SC)
10B4/1, loose, very moist to wet, 65% very fine to fine sand, 30% fat clay, 5% shell fragments, undifferentiated upper sand deposits

DARK BLUISH GRAY FAT CLAY (CH)
10B4/1, soft, moist, 90% clay, 10% shell fragments, bay mud deposits

Bottom of boring at 21.5 feet.

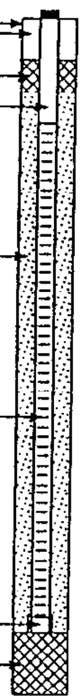
Project Number	CTO 011	Date Drilled	10/17/95
Project Name	Parcel C RI Report	GS Elevation	8.54 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	10.75 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	21.5 ft.
Equipment	Air Casing Hammer Rig, 10 in. diam.		

Figure

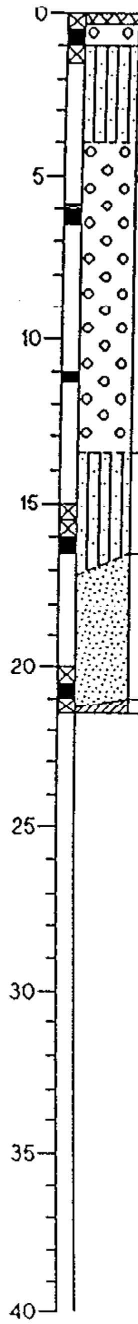
PRC Environmental Management, Inc.

LOG OF BORING IR28MW269A

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.
22 / 16 / 18	0	9542J488
16 / 14 / 8	0	9542J489
16 / 10 / 7	0	9542J490
10 / 16 / 15	0	9542J491
4 / 5 / 6		9542J492



Materials Description

ASPHALT

DARK YELLOWISH BROWN POORLY GRADED GRAVEL WITH SAND (GP)
10YR4/4, medium dense, dry, 80% fine to medium gravel, 15% fine sand, 5% fines, fill

YELLOWISH BROWN SILTY SAND WITH GRAVEL (SM)
10YR5/6, medium dense, moist, 65% very fine to fine sand, 20% silt, 15% serpentinite gravel, fill

OLIVE POORLY GRADED GRAVEL (GP)
5Y4/4, medium dense, wet, 95% fine to medium serpentinite gravel, trace fine sand and fines, fill

OLIVE SILTY SAND (SM)
5Y4/4, medium dense, moist, 75% very fine to fine sand, 20–25% silt, 5% organics (roots), undifferentiated upper sand deposits (material has diesel odor)

BLUISH GRAY POORLY GRADED SAND (SP)
5B5/1, loose, wet, 90% fine sand, 10% shell fragments, undifferentiated upper sand deposits

BLUISH GRAY FAT CLAY (CH)
5B5/1, soft, moist, 95% clay, 5% shell fragments, bay mud deposits

Bottom of boring at 21.5 feet. Boring backfilled with bentonite chips to 19.5 feet.

Project Number	CTO 011	Date Drilled	10/18/95
Project Name	Parcel C RI Report	GS Elevation	8.83 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	5 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	21.5 ft.
Equipment	Air Casing Hammer Rig, 10 in. diam.		

Figure

PRC Environmental Management, Inc.

LOG OF BORING IR28MW270A

Well Diagram

CHRISTY BOX

BOREHOLE
10 in. diameter

CONCRETE
1.0–2.0 ft.

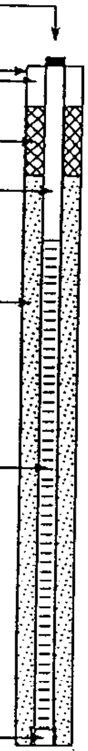
BENTONITE PELLET
SEAL
2.0–4.0 ft.

BLANK CASING
4 in. Diameter
Schedule 40 PVC
0.75–6.0 ft.

SANDPACK
RMC Lonestar #2/12
4.0–21.5 ft.

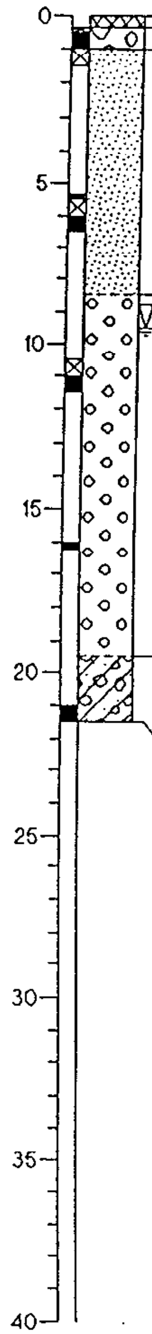
SLOTTED SCREEN
4 in. Diameter
Schedule 40 PVC
(0.010 in. slotsize)
6.0–21.0 ft.

BOTTOM WELL CAP
21.0–21.5 ft.



Blows/6 in.	OVM (ppm)	Sample No.
16, 40, 35	0	9542J497
18, 20, 21	0	9542J498
16, 15, 16	0	9542J499
50/3"	0	9542J500
16, 20, 25	0	9542J501

Depth (ft) / Samples / Symbols



Materials Description

ASPHALT

DARK OLIVE BROWN WELL-GRADED GRAVEL (GW)
2.5Y4/4, dense, dry, 90% gravel, 10% fine sand, fill

LIGHT YELLOWISH BROWN POORLY GRADED SAND (SP)
2.5Y6/4, dense, moist, 80% very fine to fine sand, 10% fines, 10% fine gravel, fill

GREENISH GRAY POORLY GRADED GRAVEL (GP)
5G5/1, medium dense, wet, 90% coarse serpentinite gravel, 10% fine to medium serpentinite sand, fill

DARK BLUISH GRAY CLAYEY GRAVEL WITH SAND (GC)
5B4/1, medium dense, wet, 65% coarse serpentinite gravel, 20% fat clay, 15% fine sand, fill

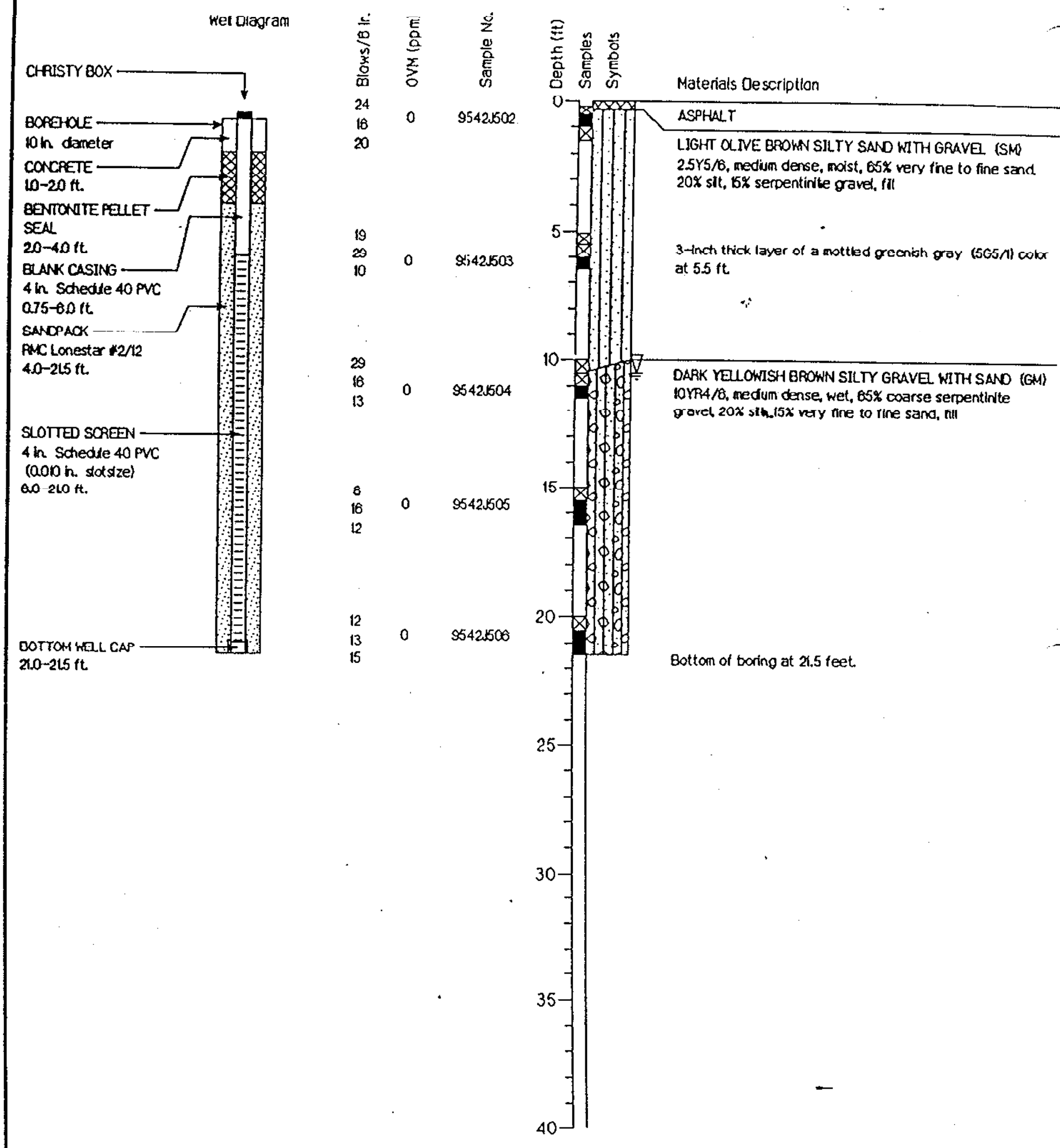
Bottom of boring at 21.5 feet

Project Number: CTO 011	Date Drilled: 10/18/95
Project Name: Parcel C RI Report	GS Elevation: 8.32 ft.
Project Task: Hunters Point Shipyard	First Encountered Wet Soil: 9.5 ft.
Project Location: San Francisco, California	Total Depth Of Borehole: 21.5 ft.
Equipment: Air Casing Hammer Rig, 10 in. diam.	

Figure

PRC Environmental Management, Inc.

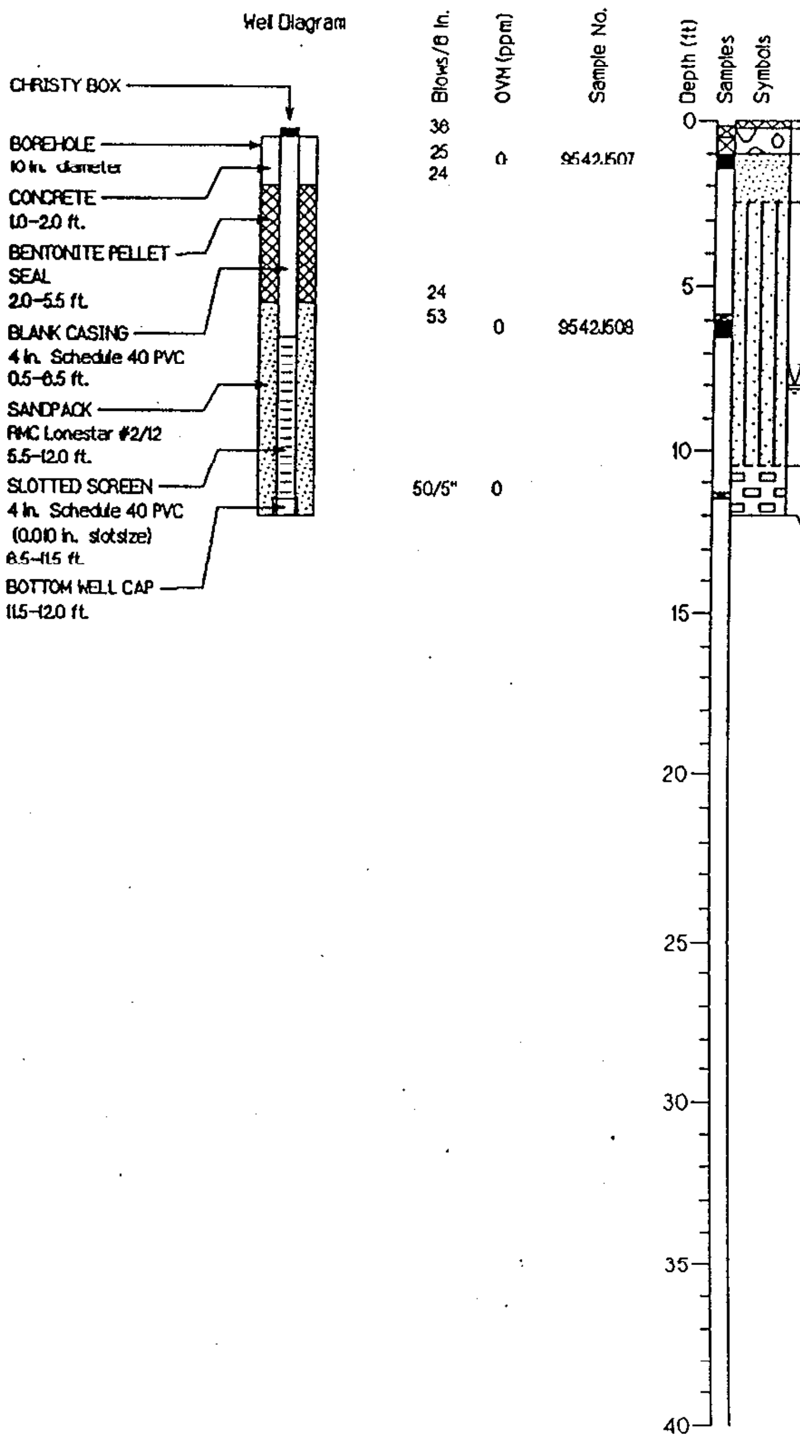
LOG OF BORING IR28MW271A



Project Number	CTO 011	Date Drilled	10/19/95
Project Name	Parcel C RI Report	GS Elevation	7.78 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	10.5 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	21.5 ft.
Equipment	Air Casing Hammer Rig, 10 in. diam.		

Figure

LOG OF BORING IR28MW272A



Materials Description

ASPHALTIC CONCRETE

VERY DARK GRAY WELL-GRADED GRAVEL WITH SAND (GW)
2.5Y3/1, dense, dry, 80% gravel, 20% sand, fill

LIGHT OLIVE BROWN POORLY GRADED SAND (SP)
2.5Y5/4, loose, dry, 95% sand, 5% fines, fill

DARK YELLOWISH BROWN SILTY SAND WITH GRAVEL (SM)
10YR4/4, hard, moist, 60% sand, 25% serpentinite gravel, 15% silt, fill

GREENISH GRAY CHERT BEDROCK (KJc)
5G4/2, hard to very hard, moderately strong, little weathering

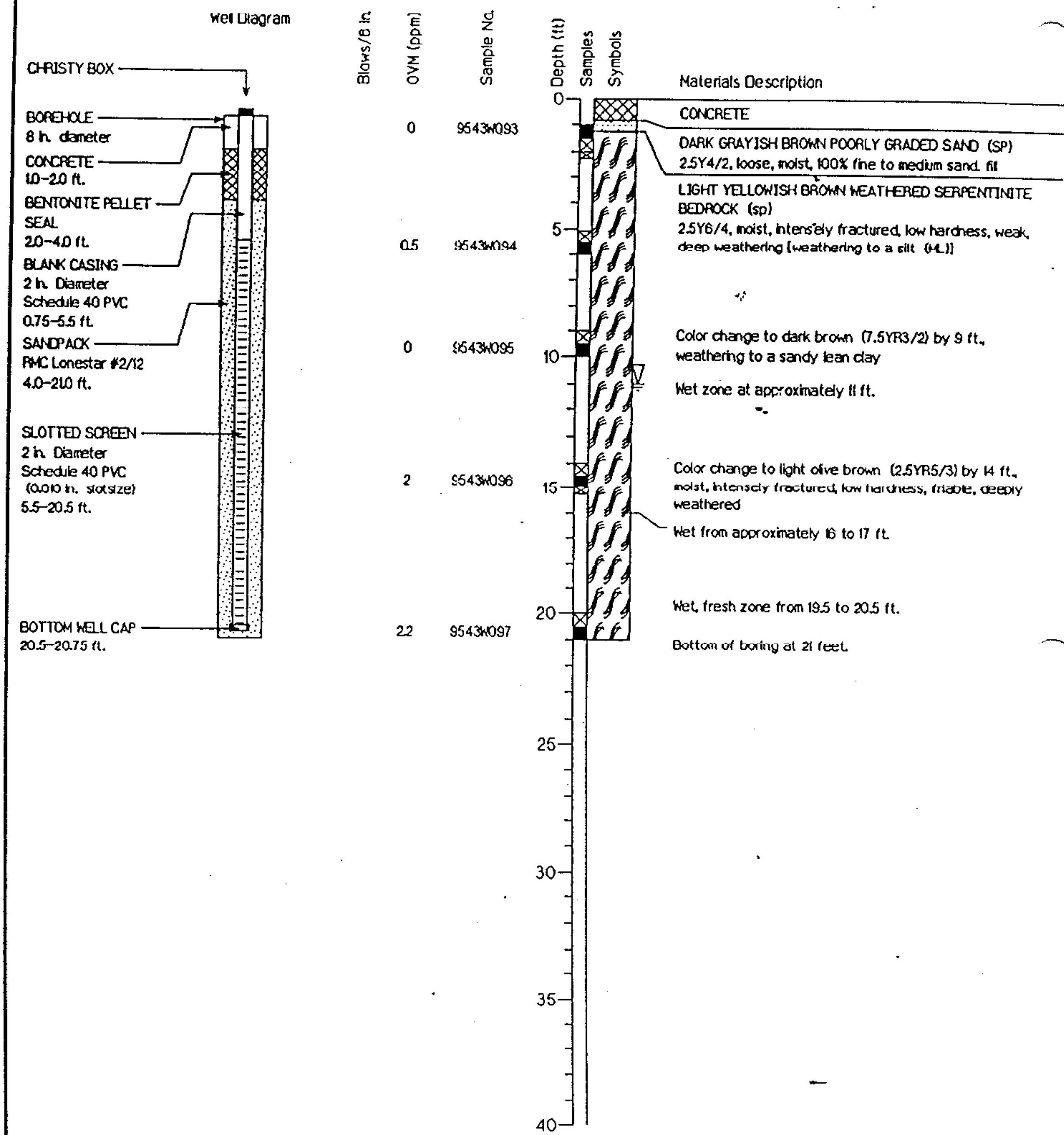
Drilling refusal at 12 feet.

Project Number	CTO 011	Date Drilled	10/19/95
Project Name	Parcel C RI Report	GS Elevation	8.49 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	8 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	12 ft.
Equipment	Air Casing Hammer Rig, 10 in. diam.		

Figure

PRC Environmental Management, Inc.

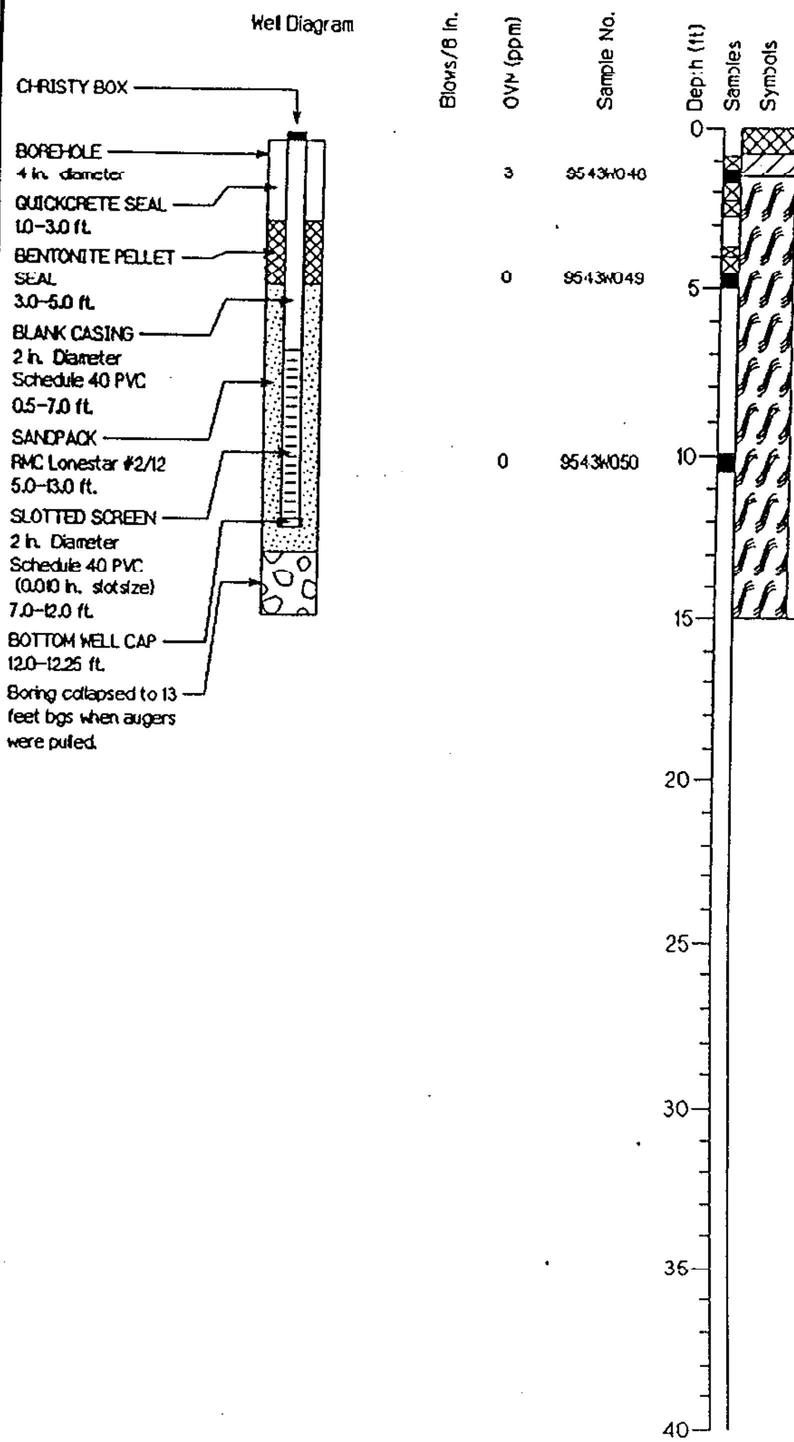
LOG OF BORING IR28MW273F



Project Number	CTO 011	Date Drilled	10/26/95	Figure
Project Name	Parcel C RI Report	GS Elevation	9.10 ft.	
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	11 ft.	
Project Location	San Francisco, California	Total Depth Of Borehole	21 ft.	
Equipment	Limited Access Rigs (Simco & Rhino), 8 in. diam.			

PRC Environmental Management, Inc.

LOG OF BORING IR28MW275F



Materials Description

CONCRETE

VERY DARK GRAYISH BROWN LEAN CLAY WITH SAND (CL)
10YR3/2, firm, moist, 85% clay, 15% fine to medium sand, fill

DARK YELLOWISH BROWN WEATHERED SERPENTINITE BEDROCK (sp)
10YR4/6, moist, intensely fractured (iron oxide staining along fractures), low hardness, weak, deeply weathered [weathering to a sandy silt (ML)]

Weathering to a sandy silt (ML) by 8.5 ft.

Hydropunch groundwater sample 9543W051 collected from borehole; screened from 14 to 15 ft.

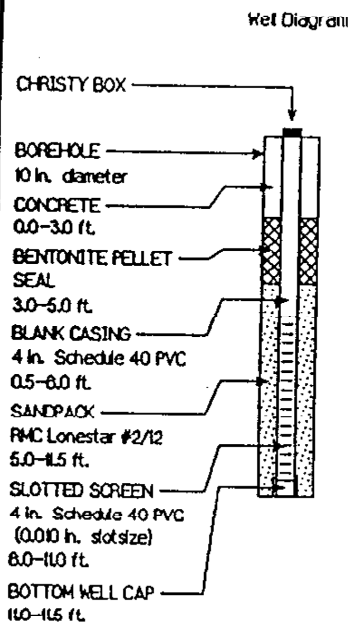
Bottom of boring at 15 feet. Boring collapsed to 13 feet bgs before well was installed.

Project Number: CTO 011	Date Drilled: 10/23/95
Project Name: Parcel C RI Report	GS Elevation: 9.00 ft.
Project Task: Hunters Point Shipyard	First Encountered Wet Soil: None Encountered
Project Location: San Francisco, California	Total Depth Of Borehole: 15 ft.
Equipment: Simco Limited Access Rig (HSA), 4 in. diam.	

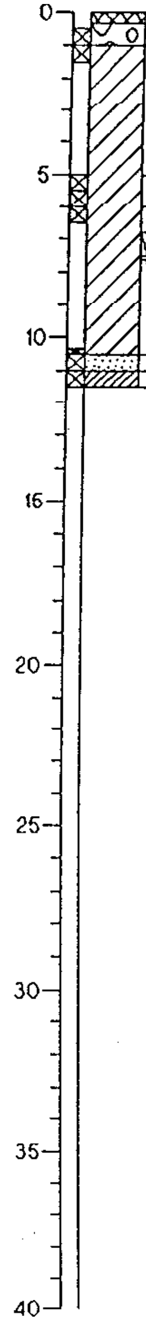
Figure

PRC Environmental Management, Inc.

LOG OF BORING IR28MW286A



Blows/6 in.	OVM (ppm)	Sample No.
7		
10		
12		
7		
12	8	
27		
4		
8		
15		



Materials Description

ASPHALT

DARK GREENISH GRAY WELL-GRADED GRAVEL WITH SAND (GW)
10Y4/1, loose, dry, 70% gravel, 30% sand, fill

DARK YELLOWISH BROWN GRAVELLY LEAN CLAY (CL)
10YR4/6, medium dense, moist, 70% clay, 20% gravel, 10% sand, fill

Color change to greenish gray (10GY5/1) by 5 ft. Sand is stained and weathered with traces of lumber/wood, fill.

Large piece of lumber/wood at 8 ft.

Color change to dark yellowish brown (10YR4/6) by 10 ft.; wet.

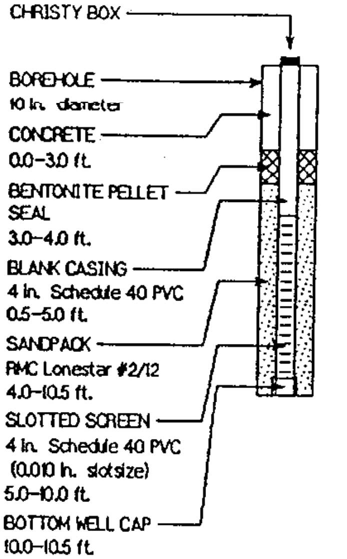
DARK GRAYISH BROWN POORLY GRADED SAND (SP)
10YR4/2, loose, wet, 50% medium sand, 40% shell fragments, 10% clay, undifferentiated upper sand deposits

DARK BLUISH GRAY FAT CLAY WITH SAND (CH)
10B4/1, 70% clay, 15% fine sand, 10% gravel, 5% shell fragments, bay mud deposits (contains interbeds of the undifferentiated upper sand deposits described above)

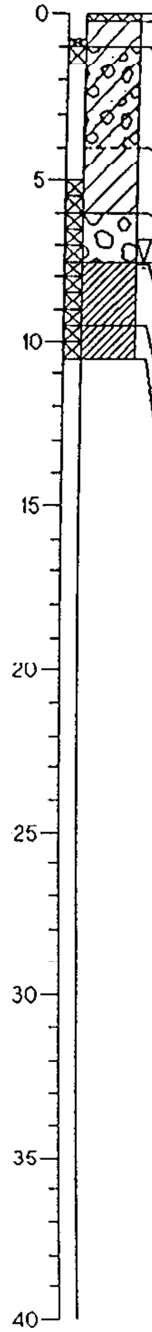
Bottom of boring at 11.5 feet.

Project Number	CTO 011	Date Drilled	09/21/95
Project Name	Parcel C RI Report	GS Elevation	10.25 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	7.5 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	11.5 ft.
Equipment	Hollow Stem Auger Rig, 10 in. diam.	Figure	

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.
37		
50/6"	0	
17		
11	0	
11		
3		
3		
3		
7		
3		
3		
3		
5		



Materials Description

ASPHALT

GRAVELLY LEAN CLAY WITH SAND (CL)
5YR3/3, hard, moist, 50% clay, 30% gravel, 20% sand, fill

DARK REDDISH BROWN CLAYEY GRAVEL (GC)
5YR3/3, hard, moist, 70% gravel, 25% clay, 5% fine sand, fill

REDDISH BROWN GRAVELLY LEAN CLAY (CL)
5YR4/3, hard, moist, 60% clay, 35% gravel, 5% sand, fill

OLIVE WELL-GRADED GRAVEL WITH SAND (GW)
5Y5/3, medium dense, moist, 65% gravel (weathered serpentinite), 35% sand, fill

3 inch wet zone with shell fragments at 7.5 ft.

VERY DARK GRAY FAT CLAY (CH)
2.5Y3/1, soft to firm, wet, 90% clay, 10% fine sand, bay mud deposits

OLIVE FAT CLAY WITH SAND (CH)
5Y5/3, soft to firm, wet, 80–85% clay, 15% sand, trace woody material, bay mud deposits

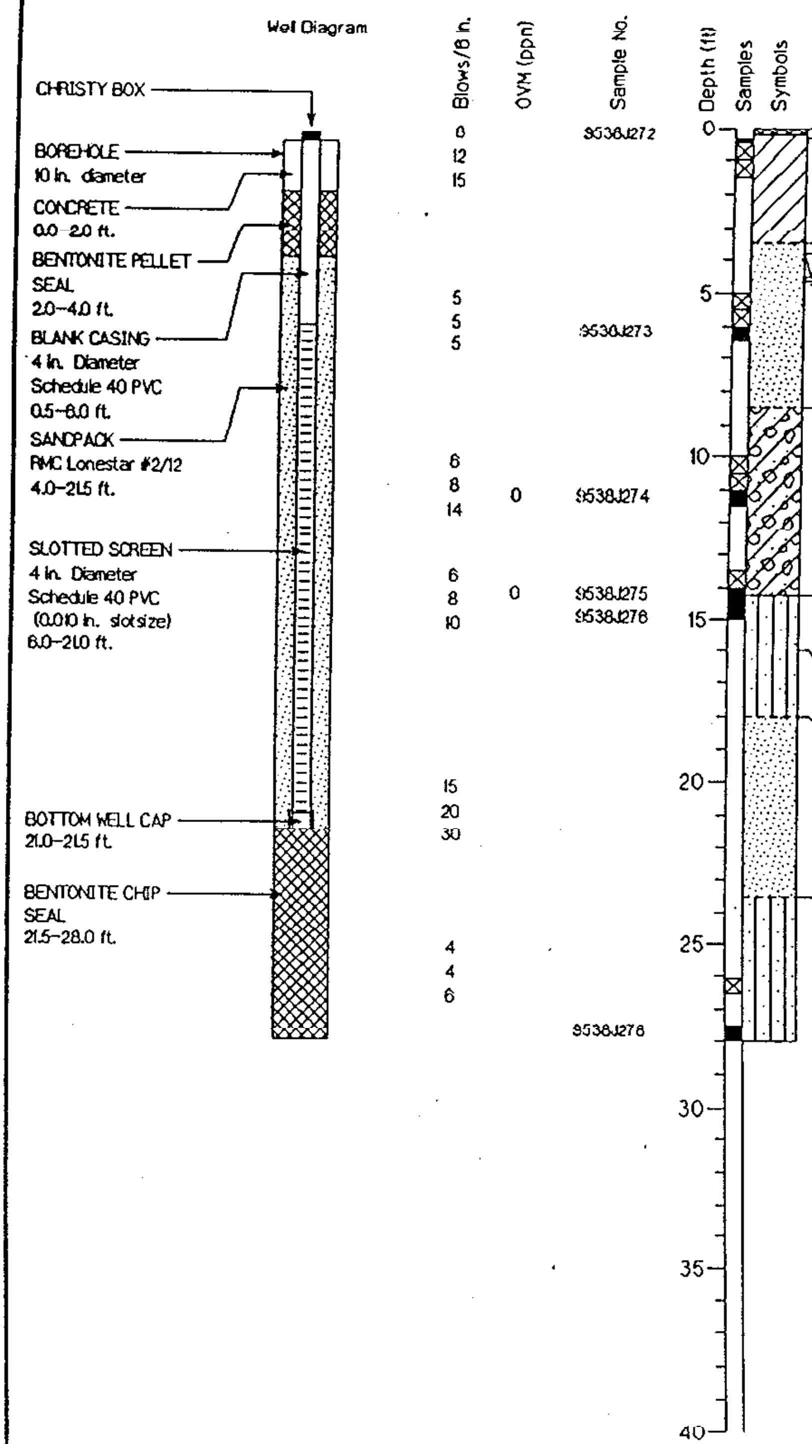
Bottom of boring at 10.5 feet

Project Number	CTO 011	Date Drilled	09/21/95
Project Name	Parcel C RI Report	GS Elevation	8.84 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	7.5 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	10.5 ft.
Equipment	Hollow Stem Auger Rig, 10 in. diam.		

Figure

PRC Environmental Management, Inc.

LOG OF BORING IR28MW290A



Materials Description

ASPHALT

DARK GRAYISH BROWN LEAN CLAY (CL)
2.5Y4/2, firm, moist, 90% clay, 10% fine sand fill

DARK GREENISH GRAY POORLY GRADED SAND (SP)
10BG4/1, loose, wet, 100% fine sand, fill

VERY DARK GRAYISH BROWN CLAYEY GRAVEL (GC)
2.5Y3/2, loose, wet, 70% gravel, 20% clay, 10% sand, fill

DARK GREENISH GRAY SILTY SAND (SM)
5BG3/1, loose, wet, 50% fine sand, 35% shell fragments, 15% silt, undifferentiated upper sand deposits

Hydropunch groundwater sample 9538J277 collected from borehole; screened from 16 to 19 ft.

DARK GREENISH GRAY POORLY GRADED SAND (SP)
10Y3/1, medium dense, wet, 80% fine sand, 20% shell fragments, undifferentiated upper sand deposits

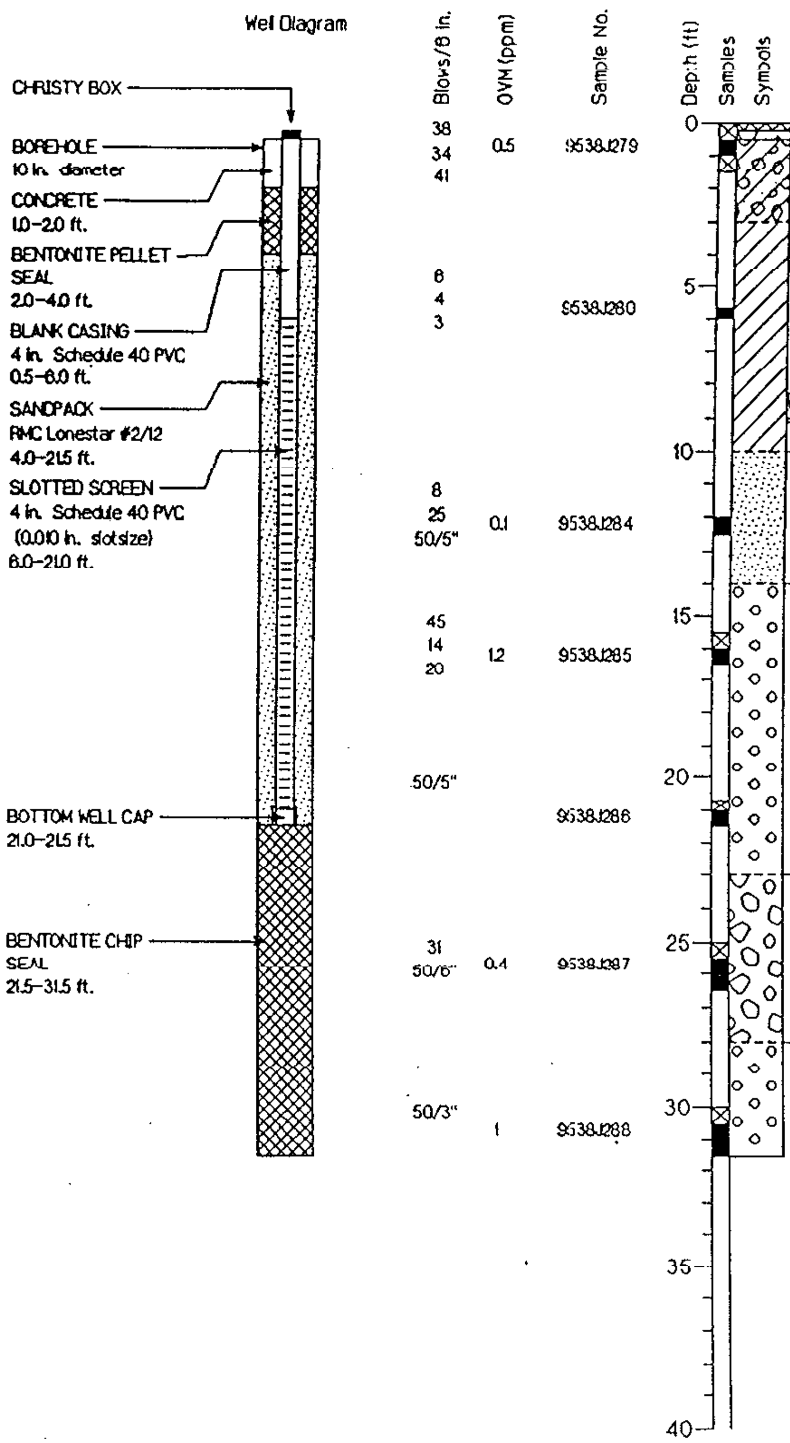
DARK YELLOWISH BROWN SILTY SAND (SM)
10YR4/4, loose, moist to wet, 70% sand, 30% silt, undifferentiated sedimentary deposits

Bottom of boring at 28 feet. Boring backfilled with bentonite chips to 21.5 feet.

Project Number: CTO 011	Date Drilled: 09/19/95	Figure
Project Name: Parcel C RI Report	GS Elevation: 8.58 ft.	
Project Task: Hunters Point Shipyard	First Encountered Wet Soil: 4.5 ft.	
Project Location: San Francisco, California	Total Depth Of Borehole: 28 ft.	
Equipment: Hollow Stem Auger Rig, 10 in. diam.		

PRC Environmental Management, Inc.

LOG OF BORING IR28MW293A



Materials Description

ASPHALT

WELL-GRADED GRAVEL (GW)
granitic in composition, fill

DARK BROWN CLAYEY GRAVEL WITH SAND (GC)
10YR3/3, dense, moist, 60% gravel, 25% clay, 15% sand, fill

DARK BROWN SANDY LEAN CLAY (CL)
10YR3/3, soft, moist, 70% clay, 20% sand, 10% gravel, fill

Hydropunch groundwater sample 9538J281 and duplicate sample 9538J282 collected from borehole; screened from 7.5 to 11 ft.

OLIVE GRAY POORLY GRADED SAND (SP)
5Y4/2, dense, wet, 100% fine sand, (grades into coarse sand), fill

OLIVE GRAY POORLY GRADED GRAVEL (GP)
5Y4/2, dense, wet, 90% gravel, 10% sand, fill

DARK GREENISH GRAY WELL-GRADED GRAVEL (GW)
5BG4/1, dense, wet, 90% coarse gravel, 10% sand, fill

DARK GREENISH GRAY POORLY GRADED GRAVEL (GP)
5BG4/1, dense, wet, 90% coarse gravel, 10% medium to coarse sand, fill

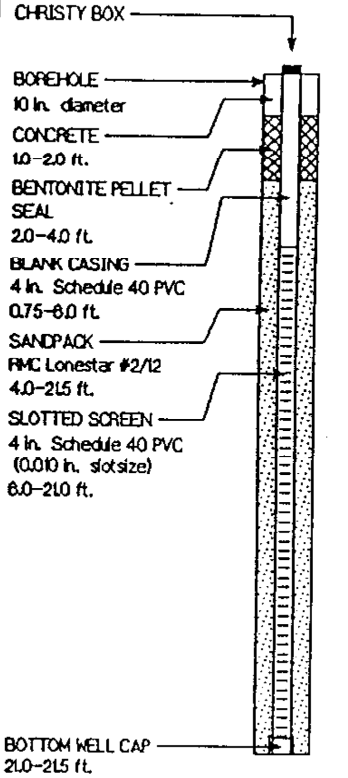
Drilling refusal at 31.5 feet. Boring backfilled with bentonite chips to 21.5 feet.

Project Number	CTO 011	Date Drilled	09/20/95
Project Name	Parcel C RI Report	GS Elevation	8.32 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	9 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	31.5 ft.
Equipment	Hollow Stem Auger Rig, 10 in. diam.		

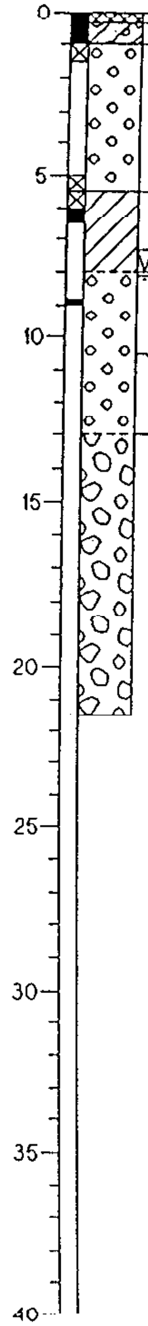
Figure

PRC Environmental Management, Inc. — LOG OF BORING IR28MW294A

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.
17 15 10	0	9540J345
28 18 14	0	9540J346
50/2"		9540J347
50/2"		
30/0"		



Materials Description

ASPHALT

DARK OLIVE BROWN CLAYEY GRAVEL WITH SAND (GC)
2.5Y3/3, medium dense, moist, 65% coarse gravel, 20% lean clay, 15% fine sand, fill

PALE OLIVE POORLY GRADED GRAVEL WITH SAND (GP)
5Y6/3, loose, dry, 80% coarse gravel, 20% fine to medium sand, fill

DARK OLIVE LEAN CLAY WITH SAND (CL)
5Y2.5/3, firm, moist, 70% clay, 20% fine sand, 10% silt, spotty grayish green (5G5/2) mottling, fill

OLIVE POORLY GRADED GRAVEL (GP)
5Y5/6, very dense, wet, 90% coarse gravel, 5% fine sand, 5% fines, fill

Hydropunch groundwater sample 9540J348 collected from borehole; screened from 10.5 to 12 ft.

GREENSTONE BOULDER FILL (BF)

No recovery from 15 to 18.5 ft.

No recovery from 19 to 20.5 ft., in greenstone boulder fill

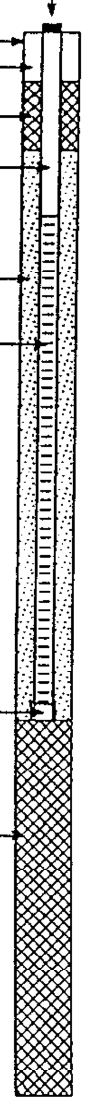
Bottom of boring at 21.5 feet.

Project Number	CTO 011	Date Drilled	10/02/95
Project Name	Parcel C RI Report	GS Elevation	8.43 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	8 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	21.5 ft.
Equipment	Air Casing Hammer Rig, 10 in. diam.	Figure	

PRC Environmental Management, Inc.

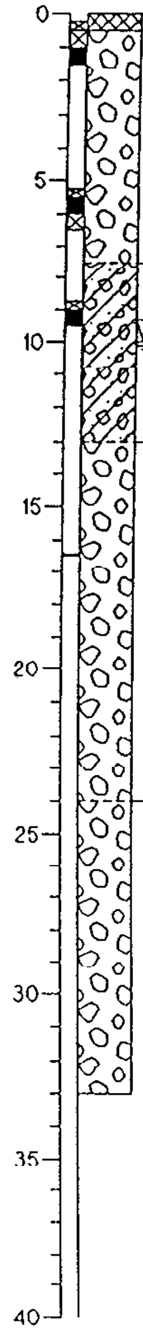
LOG OF BORING IR28MW295A

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.
10 11 13	0	9540J357
18 18 15	0	9540J358
22 17 10	0	9540J359
15 18 14		
50/2"		

Depth (ft) | Samples | Symbols



Materials Description

ASPHALT

DARK BROWN WELL-GRADED GRAVEL WITH SAND (GW) 7.5YR3/3, medium dense, dry, 75% gravel (mostly serpentinite), 20% sand, 5% clay, fill

Gravel is al serpentinite by 5 ft., 10% clay

DARK GREENISH GRAY CLAYEY GRAVEL (GC) 5G4/1, medium dense, moist, 70% gravel, 20% clay, 10% sand, fill

Hydropunch groundwater sample 9540J300 collected from borehole; screened from 10.5 to 11.5 ft.

GRAYISH GREEN WELL-GRADED GRAVEL (GW) 5G4/2, medium dense, wet, 90% gravel, 10% sand, fill

No recovery at 20 ft. Interval color change to dark olive gray (5Y3/2) by 20 ft., 85% gravel, 10% clay, 5% sand

GREENSTONE BOULDER FILL (BF)

Drilling refusal at 33 feet. Boring backfilled with bentonite chips to 21.5 feet.

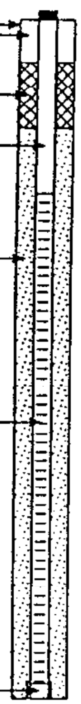
Project Number	CTO 011	Date Drilled	10/02/95
Project Name	Parcel C RI Report	GS Elevation	8.36 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	10 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	33 ft.
Equipment	Hollow Stem Auger Rig, 10 in. diam.		

Figure

PRC Environmental Management, Inc.

LOG OF BORING IR28MW297A

Well Diagram



CHRISTY BOX

BOREHOLE
10 in. diameter

CONCRETE
0.0–2.0 ft.

BENTONITE PELLET
SEAL
2.0–4.0 ft.

BLANK CASING
4 in. Diameter
Schedule 40 PVC
0.75–6.0 ft.

SANDPACK
RMC Lonestar #2/12
4.0–21.5 ft.

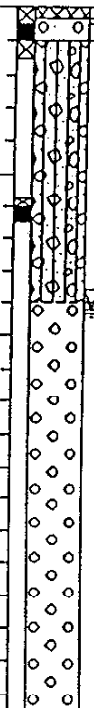
SLOTTED SCREEN
4 in. Diameter
Schedule 40 PVC
(0.010 in. slotsize)
6.0–21.0 ft.

BOTTOM WELL CAP
21.0–21.5 ft.

Blows/6 In.	OVM (ppm)	Sample No.
21 23 22	0	9542J495
5 4 8	0	9542J498
10 16 20		
10 15 18		
18 20 25		

Depth (ft): 0, 5, 10, 15, 20, 25, 30, 35, 40

Samples | Symbols



Materials Description

ASPHALT

VERY DARK BROWN POORLY GRADED GRAVEL WITH SAND (GP)
10YR2/2, medium dense, dry, 85% fine to medium gravel, 15% fine sand, fill

Color change to grayish green (5G5/2) at 0.5 ft. (all serpentinite derived sand and gravel)

LIGHT OLIVE BROWN SILTY GRAVEL (GM)
2.5Y4/4, medium dense, moist, 80% coarse gravel (not serpentinite), 15% silt, 5% fine sand, fill

POORLY GRADED GRAVEL (GP)
dense, wet, 100% coarse serpentinite gravel, fill (logged from cuttings, no recovery from 10 ft. interval)

No recovery at 15 ft. sampling interval. (Lithology is based on cuttings from cyclone.)

No recovery from 20 ft. interval. Gravel is fine. (Lithology is based on cuttings from cyclone.)

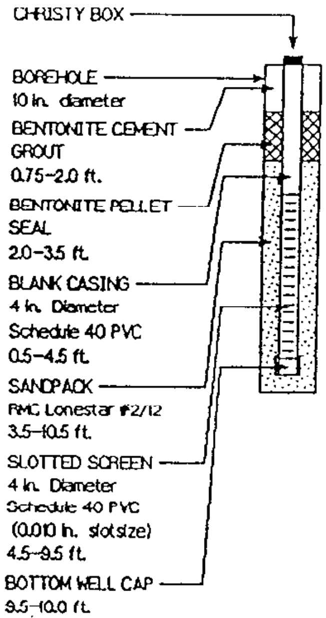
Bottom of boring at 21.5 feet.

Project Number	CTO 011	Date Drilled	10/18/95
Project Name	Parcel C RI Report	GS Elevation	8.36 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	9.25 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	21.5 ft.
Equipment	Air Casing Hammer Rig, 10 in. diam.		

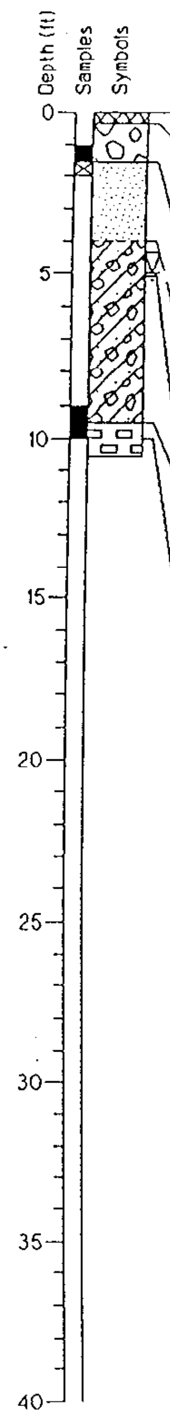
Figure

LOG OF BORING IR28MW298A

Well Diagram



Blows/6 In.	OVM (ppm)	Sample No.
20	0	9602G039
13		
7		
10		
11	0	
12		
14	0	9602G040
14		
8		



Materials Description

ASPHALT

OLIVE BROWN WELL-GRADED GRAVEL WITH SAND (GW)
2.5Y4/3, dense, moist, 75–80% fine to coarse gravel (some serpentinite, few cobbles), 20–25% fine to coarse sand, trace silt, fill

OLIVE GRAY POORLY GRADED SAND (SP)
5Y5/2, loose, moist, 95–100% fine to medium sand, trace fine gravel, fill

BROWN CLAYEY GRAVEL WITH SAND (GC)
7.5YR4/3, medium dense, wet, 60–65% fine to coarse gravel (some serpentinite), 15–20% fine to coarse sand, 10–15% clay, 5–10% silt, fill

No recovery at 5 ft. sampling interval. Sampler is wet.

DARK GREENISH GRAY AND DUSKY RED CHERT BEDROCK (KJc)
10GY4/1 and 2.5YR4/4, wet, closely fractured, moderately hard to hard, moderately strong, little weathering

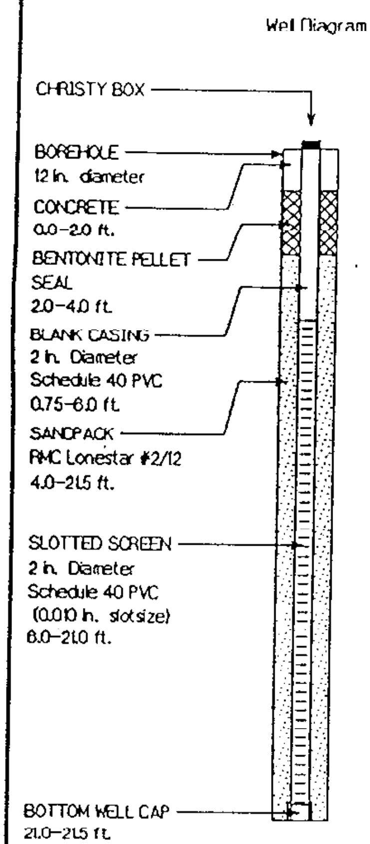
Drilling refusal on chert bedrock at 10 feet. Sampled to 10.5 feet with split-spoon sampler.

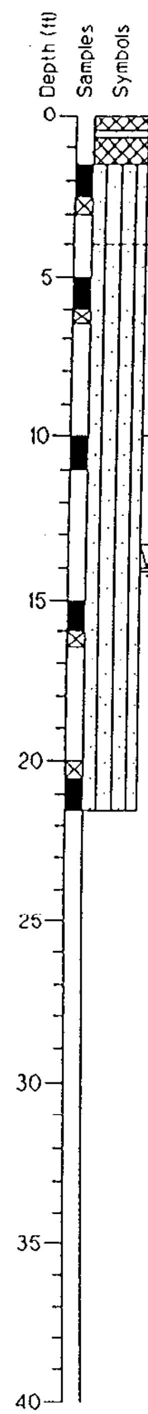
Project Number	CTO 011	Date Drilled	01/08/96
Project Name	Parcel C RI Report	GS Elevation	8.56 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	5 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	10.5 ft.
Equipment	Air Casing Hammer Rig, 10 in. diam.		

Figure

PRC Environmental Management, Inc.

LOG OF BORING IR28MW299B





Blows/6 in.	OVM (ppm)	Sample No.
	6	9606J836
	1	9606J837
	0.5	9606J838
	0.5	9606J839
	0	9606J840

Materials Description

ASPHALT

OLIVE YELLOW POORLY GRADED SAND (SP)
2.5Y6/6, loose, moist, 100% fine sand, fill

CONCRETE

OLIVE SILTY SAND WITH GRAVEL (SM)
5Y3/3, loose, moist, 65% fine sand, 20% silt, 15% fine chert and serpentinite gravel, fill

OLIVE SILTY SAND (SM)
5Y3/3, loose, moist, 70% fine sand, 25% silt, trace shell fragments and black mottled specks, undifferentiated sedimentary deposits

Color change to strong brown (7.5YR5/6) by 10 ft. No shell fragments. Layer of very dark brown (10YR2/2) staining at 10 ft. (one inch thick).

Wet at approximately 14 ft.

Bottom of boring at 21.5 feet.

Project Number CTO 011
Project Name Parcel C RI Report
Project Task Hunters Point Shipyard
Project Location San Francisco, California
Equipment Rhino Limited Access Rig (HSA), 12 in. diam.

Date Drilled 02/05/96
GS Elevation 9.94 ft.
First Encountered Wet Soil 14 ft.
Total Depth Of Borehole 21.5 ft.

Figure

PRC Environmental Management, Inc.

LOG OF BORING IR28MW300F

Well Diagram

CHRISTY BOX

BOREHOLE
10 in. diameter

CONCRETE
1.0–2.0 ft.

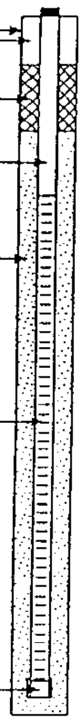
BENTONITE PELLET SEAL
2.0–4.0 ft.

BLANK CASING
4 in. Diameter
Schedule 40 PVC
0.5–6.0 ft.

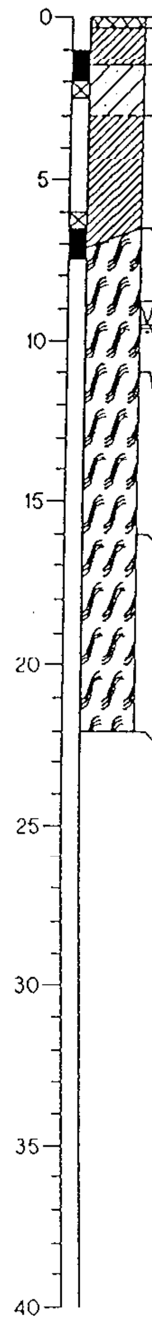
SANDPACK
RMC Lonestar #2/12
4.0–22.0 ft.

SLOTTED SCREEN
4 in. Diameter
Schedule 40 PVC
(0.010 in. slotsize)
6.0–21.0 ft.

BOTTOM WELL CAP
21.0–21.5 ft.



Blows/6 In.	OVM (ppm)	Sample No.
10 12 42	0	96066077
9 15 30	0	96066078
50/4"		



Materials Description

ASPHALT

VERY DARK GRAYISH BROWN GRAVELLY FAT CLAY WITH SAND (CH)
10YR3/2, firm, moist, 50–55% clay, 15–20% fine to coarse gravel, 15% fine to medium sand, 10–15% silt, fill

DARK YELLOWISH BROWN CLAYEY SAND (SC)
10YR4/6, dense, moist, 80–85% fine to medium poorly graded sand, 10–15% fat clay, 5% silt, undifferentiated sedimentary deposits

OLIVE BROWN FAT CLAY WITH GRAVEL (CH)
2.5Y4/3, firm, moist, 80–85% clay, 15–20% fine serpentinite gravel (weathered serpentinite bedrock)

OLIVE SERPENTINTE BEDROCK (sp)
5Y5/4, moist, closely fractured, low to moderate hardness, weak, moderate weathering

Wet at approximately 9.5 ft. (Lithology is based on cuttings.)

No recovery at 11 ft. Bedrock is too hard to drive sampler more than 4 in.; same as above based on cuttings.

Not able to sample at 16 ft. because bedrock is too hard; same as above based on cuttings.

Not able to sample at 21 ft. because bedrock is too hard; same as above based on cuttings.

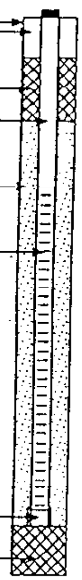
Bottom of boring at 22 feet.

Project Number	CTO 011	Date Drilled	02/05/96	Figure
Project Name	Parcel C RI Report	CS Elevation	9.88 ft.	
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	9.5 ft.	
Project Location	San Francisco, California	Total Depth Of Borehole	22 ft.	
Equipment	Air Rotary Casing Hammer, 10 in. diam.			

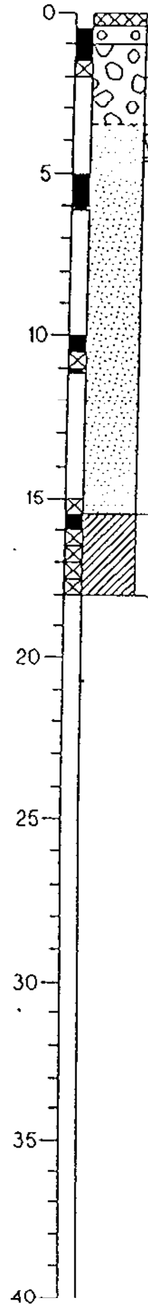
PRC Environmental Management, Inc.

LOG OF BORING IR28MW308A

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.	Depth (ft)
8, 5, 6	0	9613J974	0
3, 1, 4	0	9613J975	5
3, 1, 1	0	9613J976	10
1, 1, 1, 1, 1, 1		9613J977	15



Materials Description

ASPHALT

DARK BROWN POORLY GRADED GRAVEL (GP)
7.5YR3/3, dense, moist, 80% coarse chert gravel, 10% fine to medium sand, 10% silt, fill

PALE GREEN WELL-GRADED GRAVEL (GW)
5G6/2, dense, moist, 100% serpentinite gravel, fill

Gravel is deeply weathered by 2 ft.

OLIVE POORLY GRADED SAND (SP)
5Y3/3, loose, wet, 90% coarse sand, 10% shell fragments, undifferentiated upper sand deposits

Color change to dark greenish gray (5G4/1) by 10 ft., wet, 90% fine sand, 10% lean clay (clay appears as 0.5 inch diameter nodules), trace shell fragments

DARK BLUISH GRAY FAT CLAY (CH)
10B4/1, soft, moist, 90% clay, 5% shell fragments, 5% organics (possibly roots), bay mud deposits

Bottom of boring at 18 feet. Boring backfilled with bentonite pellets to 16.5 feet.

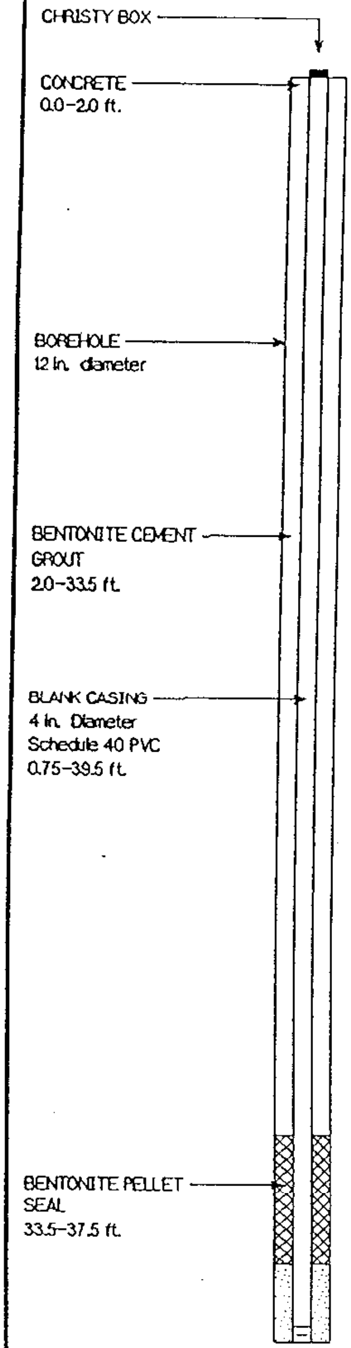
Project Number	CTO 011	Date Drilled	03/27/98
Project Name	Parcel C RI Report	GS Elevation	8.14 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	4.5 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	18 ft.
Equipment	Air Rotary Casing Hammer, 12 in. diam.		

Figure

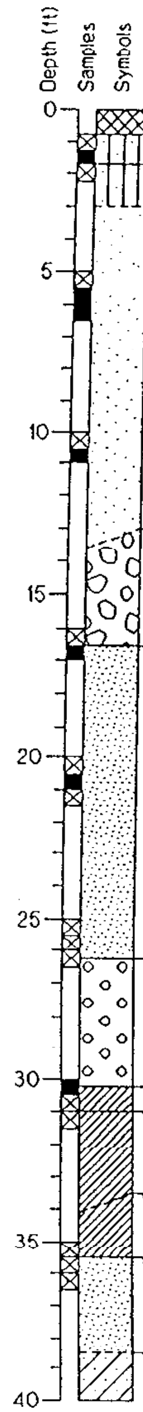
PRC Environmental Management, Inc.

LOG OF BORING IR28MW309B

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.
6 6 12	0	9613J984
7 6 5	3.5	9613J985
8 10 11	0	9613J986
8 16 4	0	9613J987
6 5 5	3.1	9613J988
8 6 5	2.2	
18 9 6	0	9613J989
8 12 12	2.7	
9		



Materials Description

ASPHALT (TWO DISTINCT LAYERS, EACH 4.5 IN. THICK)

BLACK SILTY SAND WITH GRAVEL (SM)
N2.5/, medium dense, moist, 65% fine sand, 20% silt, 15% fine serpentinite gravel, fill

LIGHT OLIVE BROWN SILTY SAND (SM)
2.5YR5/4, 80% fine sand, 15% silt, 5% fine chert gravel, fill

OLIVE WELL-GRADED SAND (SW)
5Y4/4, medium dense, wet, 80% chert sand, 10% fine chert gravel, 10% shell fragments, fill

Color change to pale green (5G6/2) by 10.5 ft., 90% serpentinite sand, 10% fine serpentinite gravel, trace shell fragments

PALE GREEN WELL-GRADED GRAVEL (GW)
5G6/2, dense, wet, 95% serpentinite gravel, 5% shell fragments, fill

DARK BLUISH GRAY POORLY GRADED SAND (SP)
10B4/1, loose, wet, 85% fine sand, 10% shell fragments, 5% fines, undifferentiated upper sand deposits

75% fine sand, 20% shell fragments, 5% fines by 20 ft.

3 inch thick layer of sandy fat clay at 25.5 ft.

DARK BLUISH GRAY POORLY GRADED GRAVEL (GP)
10B4/1, medium dense, moist, 95% fine to medium serpentinite gravel, 5% shell fragments

OLIVE FAT CLAY (CH)
5Y3/3, firm, moist, 95% clay, 5% roots and root remnants, bay mud deposits

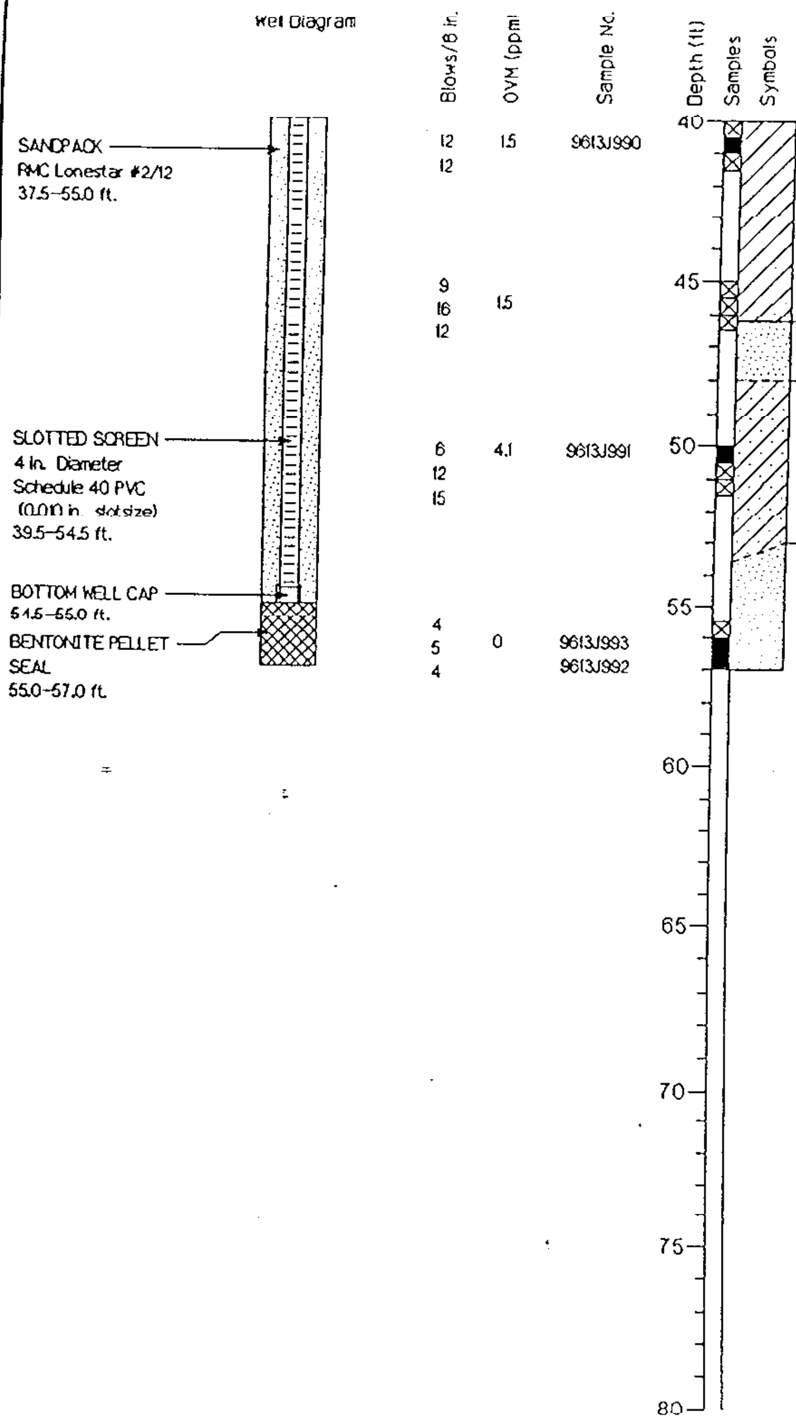
BLACK FAT CLAY WITH SAND (CH)
N2.5/, soft, moist, 80% clay, 20% fine sand, trace white very fine sand-sized granules present throughout interval. bay mud deposits

DARK GRAYISH GREEN FAT CLAY WITH SAND (CH)
5G3/2, firm, moist, 80% clay, 20% fine sand, bay mud deposits

DARK GRAYISH GREEN POORLY GRADED SAND (SP)
5G3/2, dense, moist, 95–99% fine sand, trace to 5% fines, undifferentiated sedimentary deposits

Project Number: CTO 011	Date Drilled: 03/28/96
Project Name: Parcel C RI Report	GS Elevation: 9.52 ft.
Project Task: Hunters Point Shipyard	First Encountered Wet Soil: 3 ft.
Project Location: San Francisco, California	Total Depth Of Borehole: 57 ft.
Equipment: Air Rotary Casing Hammer, 12 in. diam.	

Figure



Materials Description

OLIVE CLAYEY SAND (SC)
5Y4/4, dense, moist, 80% fine sand, 15% fat clay, 5% silt, undifferentiated sedimentary deposits

OLIVE POORLY GRADED SAND (SP)
5Y4/4, dense, moist, 100% fine sand, trace chert gravel, undifferentiated sedimentary deposits

OLIVE CLAYEY SAND (SC)
5Y4/4, dense, moist, 55% fine sand, 45% fat clay, undifferentiated sedimentary deposits

OLIVE POORLY GRADED SAND (SP)
5Y4/4, medium dense, very moist, 98% fine sand, 2% fines, undifferentiated sedimentary deposits

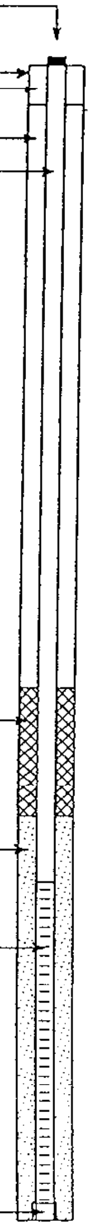
Bottom of boring at 57 feet. Boring backfilled with bentonite chips to 55 feet.

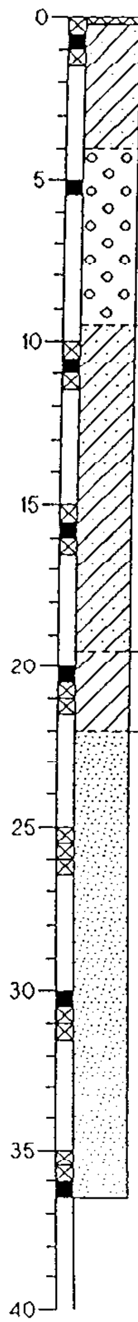
Project Number CTO 011	Date Drilled 03/28/98	Figure
Project Name Parcel C RI Report	GS Elevation 9.52 ft.	
Project Task Hunters Point Shipyard	First Encountered Wet Soil 3 ft.	
Project Location San Francisco, California	Total Depth Of Borehole 57 ft.	
Equipment Air Rotary Casing Hammer, 12 in. diam.		

PRC Environmental Management, Inc.

LOG OF BORING IR28MW310F

Well Diagram



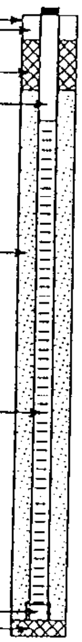


Depth (ft)	Blows/6 in.	OVM (ppm)	Sample No.	Materials Description
0	3, 5, 6	0	9614J994	ASPHALT VERY DARK BROWN CLAYEY SAND WITH GRAVEL (SC) 10YR2/2, medium dense, moist, 55% fine to medium sand, 30% lean clay, 15% coarse chert gravel, fill
5	3, 1, 2	0	9614J995	VERY DARK BROWN POORLY GRADED GRAVEL WITH SAND (GP) 10YR2/2, loose, wet, 85% fine gravel, 15% fine to medium sand, fill
10	3, 1, 1	0	9614J996	OLIVE CLAYEY SAND (SC) 5Y4/4, loose, wet, 80% fine sand, 20% lean clay, trace shell fragments, undifferentiated upper sand deposits
15	1, 1, 1	0	9614J997	Color change to yellowish brown (10YR5/6) by 15 ft.
20	3, 2, 15	0	9614J998	YELLOWISH BROWN LEAN CLAY (CL) 10YR5/4, firm, moist, 95% clay, 5% coarse chert gravel, undifferentiated sedimentary deposits YELLOWISH BROWN SANDSTONE BEDROCK (KJss) 10YR5/4, moderately consolidated, intensely fractured, moderately hard, deeply weathered (chert in sample and in cuttings; probably represent chert interbeds)
25	18, 15, 12	0		
30	40, 50/6"	0	9614J999	
35		0	9614J001	Bottom of boring at 36.5 feet.

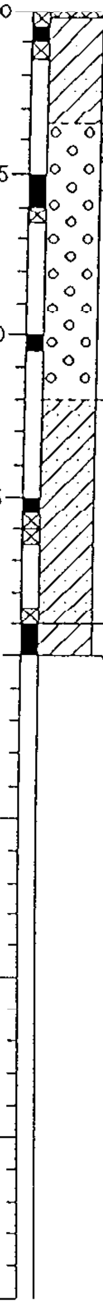
Project Number	CTO 011	Date Drilled	04/01/98
Project Name	Parcel C RI Report	GS Elevation	8.37 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	4.25 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	36.5 ft.
Equipment	Air Rotary Casing Hammer, 12 in. diam.		

Figure

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.	Depth (ft)
3, 8, 8		9614J002	0
6, 5, 4	0	9614J003	5
8, 8, 10	0	9614J004	10
3, 2, 1	0	9614J005	15
12, 8, 10		9614J006, 9614J007	20
			25
			30
			35
			40



Samples / Symbols / Materials Description

ASPHALT

DARK YELLOWISH BROWN CLAYEY SAND WITH GRAVEL (SC)
10YR3/4, dense, moist, 50% fine sand, 30% lean clay, 15% fine serpentinite and chert gravel, 5% silt, fill

Cuttings contain wood fragments and have a slight creosote odor.

DARK BROWN POORLY GRADED GRAVEL WITH SAND (GP)
7.5YR3/4, medium dense, wet, 85% coarse chert gravel, 15% fine to medium sand, trace shell fragments, fill

4-inch thick layer of dark greenish gray (5BG4/1) poorly graded sand (SP), 100% fine to medium sand with trace shell fragments at 5.5 ft.

YELLOWISH BROWN CLAYEY SAND (SC)
10YR4/6, loose, moist, 85% fine sand, 15% lean clay, trace shell fragments, undifferentiated upper sand deposits

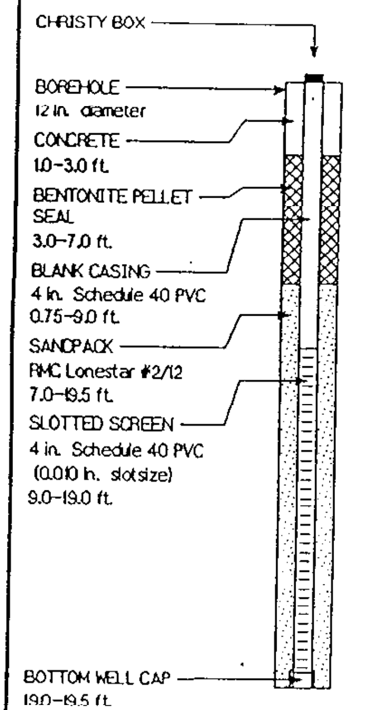
YELLOWISH BROWN LEAN CLAY (CL)
10YR4/6, firm, moist, 95% clay, 5% fine chert gravel, undifferentiated sedimentary deposits

Bottom of boring at 20 feet. Boring backfilled with bentonite chips to 19.5 feet.

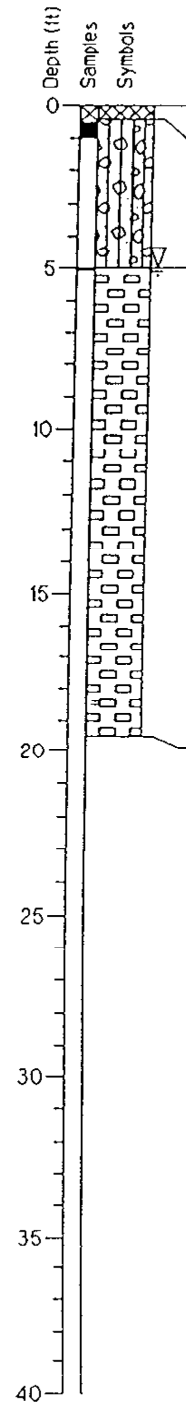
Project Number: CTO 011	Date Drilled: 04/01/98
Project Name: Parcel C RI Report	GS Elevation: 8.37 ft.
Project Task: Hunters Point Shipyard	First Encountered Wet Soil: 4.5 ft.
Project Location: San Francisco, California	Total Depth Of Borehole: 20 ft.
Equipment: Air Casing Hammer Rig, 12 in. diam.	Figure

LOG OF BORING IR28MW312F

Well Diagram



Blows/6 In.	OVM (ppm)	Sample No.	Depth (ft)
3 6 8	0	9614J008	0
50/1"	0		5



Materials Description

ASPHALT

REDDISH BROWN SILTY GRAVEL WITH SAND (GM)
5YR4/4, medium dense, moist, 65% coarse chert gravel, 20% silt, 15% fine to medium sand, fill

PALE GREEN CHERT BEDROCK (KJc)
5G6/2, moderately to closely fractured, wet, weak to moderately strong, very little to no weathering observed

Abundant water being produced by formation at 8 ft.

No sampling attempted at 10 ft. because formation is too hard; same as above based on cuttings.

No sampling attempted at 15 ft. because formation is too hard; same as above based on cuttings.

No sampling attempted at 18 ft. because formation is too hard; same as above based on cuttings.

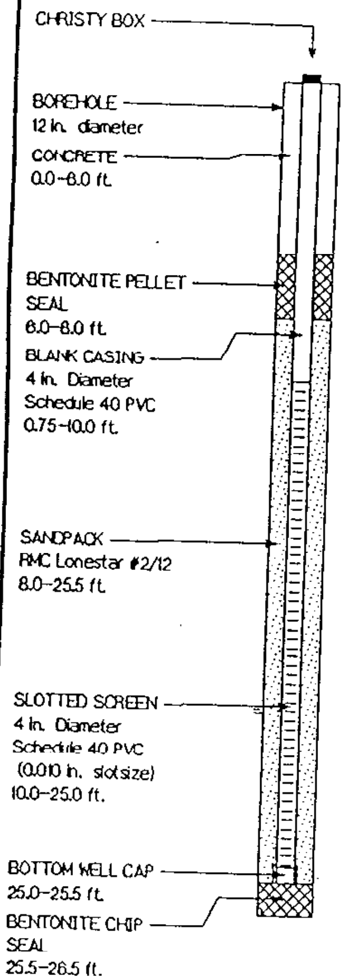
Bottom of boring at 19.5 feet.

Project Number	CTO 011	Date Drilled	04/02/96
Project Name	Parcel C RI Report	GS Elevation	8.78 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	5 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	19.5 ft.
Equipment	Air Rotary Casing Hammer, 12 in. diam.	Figure	

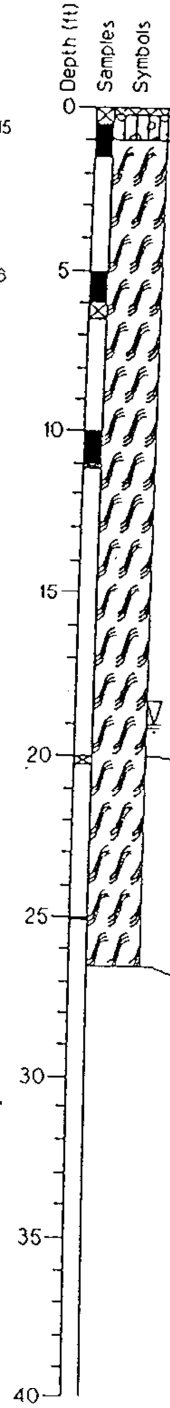
PRC Environmental Management, Inc.

LOG OF BORING IR28MW313F

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No	Depth (ft)
6 8 8	0	9614J015	0
8 12 15	0	9614J016	5
50 50/2"	0	9614J017	10
			15
50/5"	0		20
50/1"			25
			30
			35
			40



Materials Description

ASPHALT

OLIVE SILTY GRAVEL WITH SAND (GM)
5Y4/4, medium dense, moist, 65% fine serpentinite gravel, 20% silt, 15% fine to medium sand, fill

DARK GREENISH GRAY SERPENTINITE BEDROCK (sp)
5G4/4, moist to dry, moderately hard, concoidal fractures

Very difficult drilling; no sampling attempted at 15 ft. because formation is too hard (same as above based on cuttings).

Wet cuttings at 19 ft.

Very little recovery at 20 ft.; no sample submitted to lab.

Very little recovery at 25 ft.; no sample submitted to lab. Formation is producing abundant water.

Bottom of boring at 26.5 feet. Boring backfilled with bentonite chips to 25.5 feet.

Project Number CTO 011
Project Name Parcel C RI Report
Project Task Hunters Point Shipyard
Project Location San Francisco, California
Equipment Air Rotary Casing Hammer, 12 in. diam.

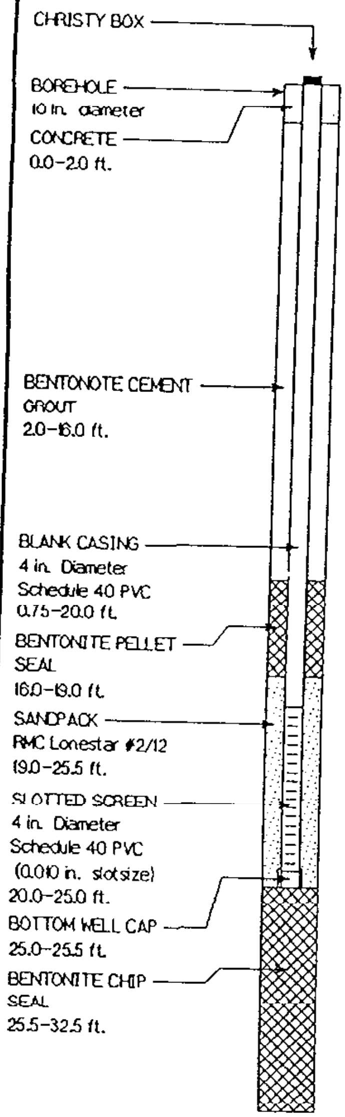
Date Drilled 04/03/98
GS Elevation 9.78 ft.
First Encountered Wet Soil 19 ft.
Total Depth Of Borehole 26.5 ft.

Figure

PRC Environmental Management, Inc.

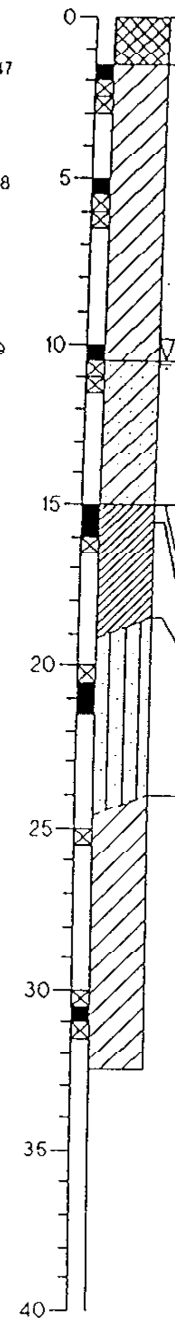
LOG OF BORING IR28MW314B

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.
3 3 4	0.5	9617J047
3 5 4	0	9617J048
9 10 12	0	9617J049
3 6 5	2	9617J050
5 6 3	2	9617J051
8 10 16	15	
18 12 21	1	9617J052

Depth (ft) | Samples | Symbols



Materials Description

CONCRETE

GREENISH GRAY LEAN CLAY WITH GRAVEL (CL)
5G5/1, soft, moist 85% weathered serpentinite clay, 15% fine to medium gravel, fill

DARK GREENISH GRAY CLAYEY SAND WITH GRAVEL (SC)
5G4/1, medium dense, moist, 50% fine sand, 30% lean clay, 20% medium to coarse serpentinite gravel, fill

DARK GREENISH GRAY FAT CLAY (CH)
5G3/1, soft, moist, 95% clay, 5% shell fragments, bay mud deposits

Trace gravel at 15 ft.

2 inch thick layer of stained black clayey sand at 15.5 ft.

DARK BLUISH GRAY SILTY SAND (SM)
5B3/1, loose, wet, 65% fine sand, 15% silt, 20% shell fragments, undifferentiated upper sand deposits

OLIVE LEAN CLAY WITH SAND (CL)
5Y4/4, firm, moist, 80% clay, 15 % fine sand, 5% silt, undifferentiated sedimentary deposits

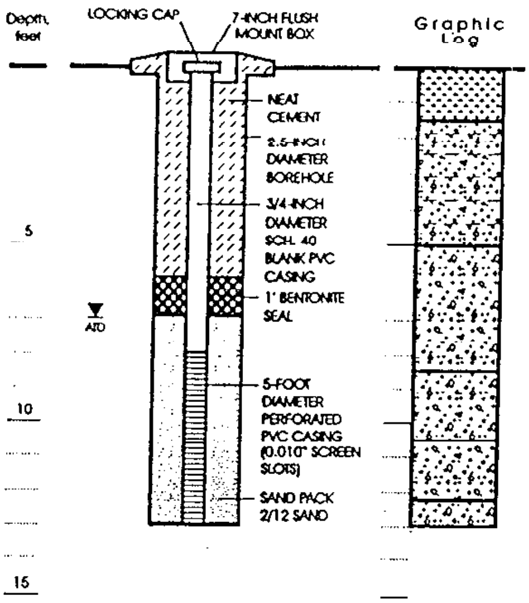
Bottom of boring at 32.5 feet. Boring backfilled with bentonite chips to 25.5 feet.

Project Number	CTO 011	Date Drilled	04/24/96
Project Name	Parcel C RI Report	GS Elevation	9.00 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	10.5 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	32.5 ft.
Equipment	Air Casing Hammer Rig, 10 in. diam.		

Figure

WELL CONSTRUCTION	LITHOLOGY	SAMPLE DATA

Depth, feet — Graphic Log — Description — Sample Interval — Penetration Rate (Blows/ft.) — PID (ppm)



CEMENT FLOOR, 18" THICK.

Hand Auger to 5', weathered serpentine.

SILTY GRAVEL (GM), light greenish gray, rock up to 10 cm, slickenside on rock fragment, minor clay and talc.

COBBLES/GRAVEL, weathered serpentine fill, light greenish gray, soft, friable, fractures, minor talc.

SERPENTINE FILL, highly fractured, wet, olive green, <2 cm, calcite on some fracture surface, minor clay, no talc.

SERPENTINE FILL, black, wet, hard, no clays or talc, highly fractured.

SERPENTINE FILL, black, wet, highly fractured, minor gray clay, fragment <1 cm.

BOTTOM OF BORING AT 13 FEET.

Well Permit No:
Date Well Drilled: December 16, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION

Clay
Silt
Sand
Gravel

Interval sampled using Push Point Sampler

Soil sample collected for analysis

ATD Depth first water was encountered in borehole

Approved by: [signature] RG6564

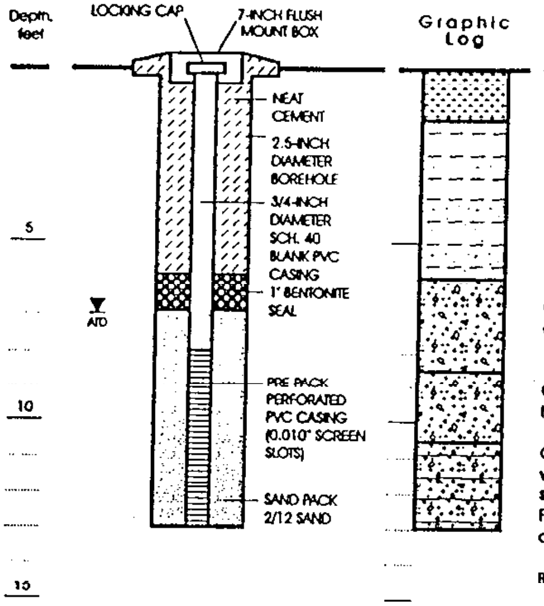
WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW324A (page 1 of 1)

Levine·Fricke·Recon

Project No. 5109

Figure

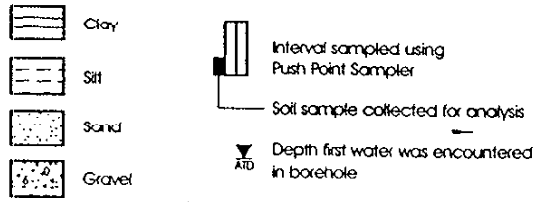
WELL CONSTRUCTION	LITHOLOGY	SAMPLE DATA



Description	Sample Interval	Penetration Rate (Blows/ft.)	PID (ppm)
CEMENT FLOOR, 18" THICK.			
Hand Augered to 5'. SILTY SAND (SM), dark greenish gray (5BG 4/1) weathered serpentine, brownish green, moist, 20% clay, 80% sand and gravel, minor talc, slickenside on fracture surfaces of rock.			
COBBLES/GRAVEL (GW), weathered serpentine, brownish green, moist, 40% silt, 60% rock fragment, slickenside.			
COBBLES/GRAVEL (GW), serpentine, black, (5Y 2.5/1), wet, hard, highly fractured, <1 cm, no clay or talc.			
CLAYEY GRAVEL (GC), weathered clay and serpentine, wet, blueish gray to black, 30% clay, slickenside on surfaces, minor brown clay. Fractured black serpentine, wet, minor blueish dark gray clay, <1 cm rock fragments, hard.			
BOTTOM OF BORING AT 13 FEET.			

Well Permit No:
Date Well Drilled: December 16, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION



Approved by: [signature] RG 6567

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW325A *(page 1 of 1)*

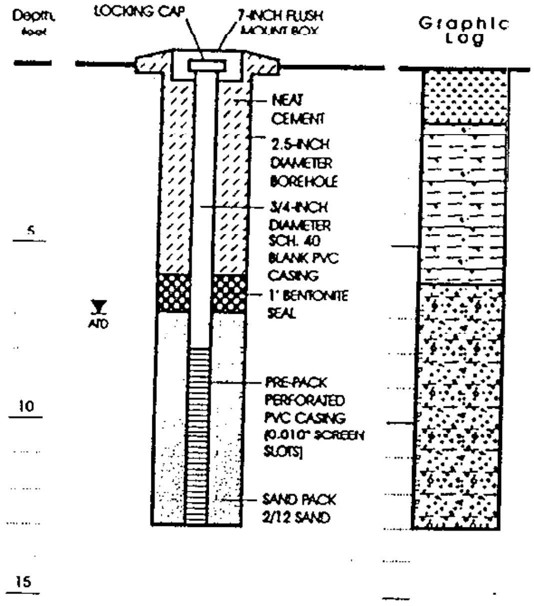
Levine·Fricke·Recon

Project No. 5109

Figure

5109L018.CDR 040398

WELL CONSTRUCTION	LITHOLOGY	SAMPLE DATA



Depth	Description	Sample Interval	Penetration Rate (Blows/ft.)	PID (ppm)
	CONCRETE FLOOR, 14" THICK.			
	Hand Augered to 5'.			
5	GRAVELLY SILT (ML), weathered serpentine, slightly moist, greenish gray, 80% silt, 20% rock fragments up to 2" minor red clay			
	SILTY GRAVEL (GM), weathered serpentine fill, slightly moist, greenish gray, 60% rock fragment <1 cm, 40% silt.			
10	Dark greenish gray, 10% silts.			
	40% Silt.			
	Wet, greenish gray, 20% silts.			
	BOTTOM OF BORING AT 13 FEET.			
15				

Well Permit No:
Date Well Drilled: December 17, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION

Clay
Silt
Sand
Gravel

Interval sampled using Push Point Sampler
Soil sample collected for analysis
ATD Depth first water was encountered in borehole

Approved by: [signature] RG6568

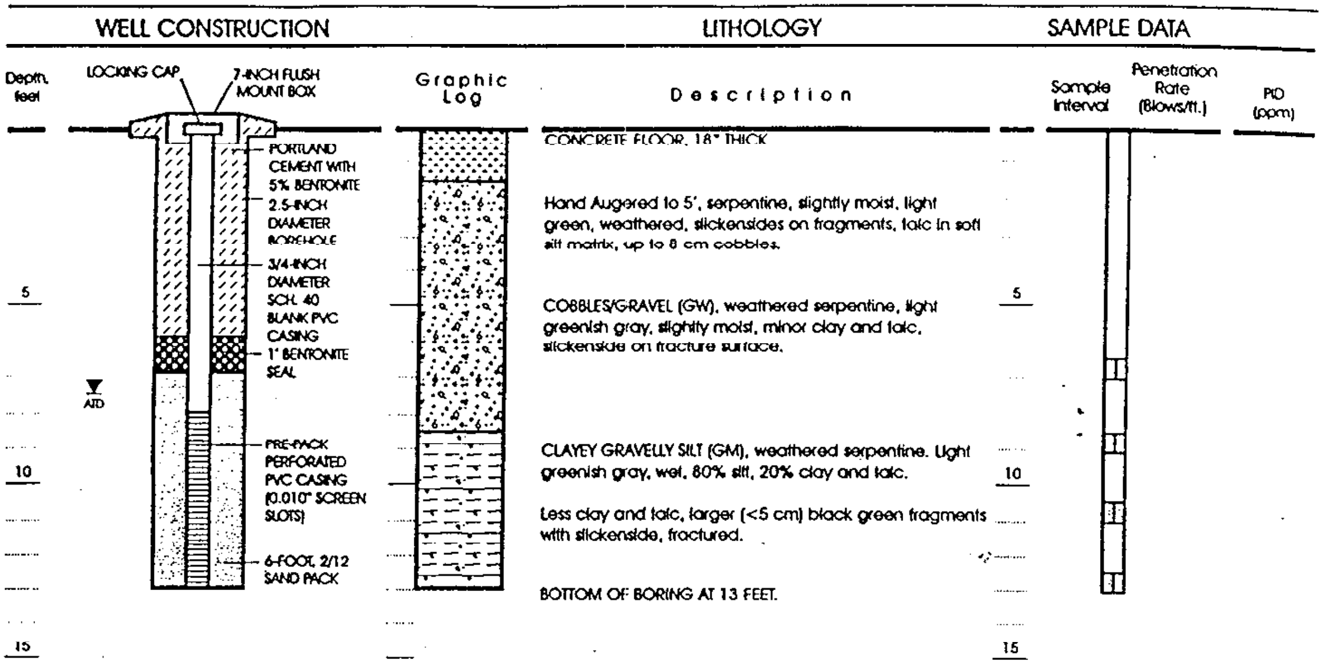
WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW326A *(page 1 of 1)*

Levine·Fricke·Recon

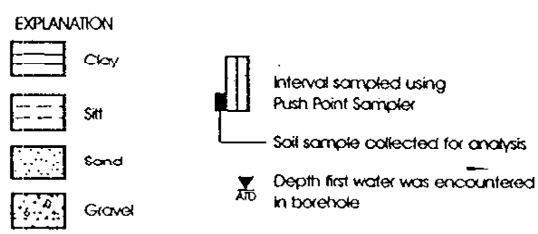
Project No. 5109

Figu

5109L019.CDR 040398



Well Permit No:
Date Well Drilled: December 16, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)



Approved by: [signature] RG 6568

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW327A *(page 1 of 1)*

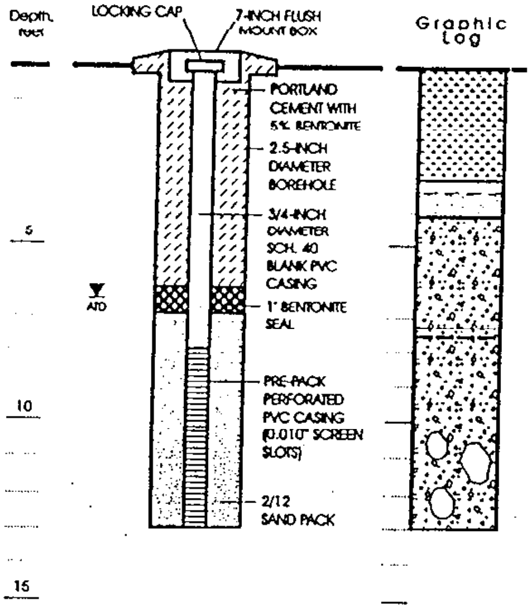
Levine·Fricke·Recon

Figure

Project No. 5109

5109L020.CDR 040398

WELL CONSTRUCTION | LITHOLOGY | SAMPLE DATA



Description

CONCRETE FLOOR, 3'.

Hand augered 3 to 5 feet.

SILTY SAND (SM), FILL, light yellowish brown (10YR 6/4), slightly moist 15% silt, 85% sand, minor clay, medium grained, angular to subangular.

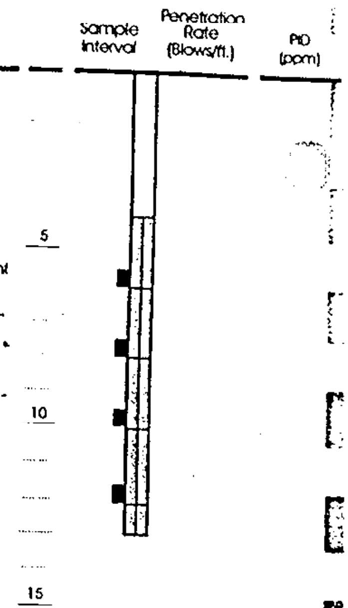
COBBLES/GRAVEL (GW), weathered serpentine, dark green, slightly moist, fractured, slickenside and fragment >5 cm, minor clay and talc, friable.

GRAVEL (GW), fractured serpentine, dark greenish black, slightly moist, <2 cm fragments, hard, no clays, slickensides present.

GRAVEL (GW), weathered serpentine, wet, light greenish gray, highly fractured, <2 cm fragments, slickenside.

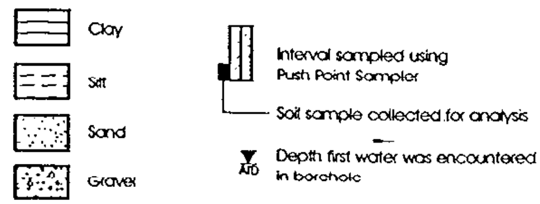
COBBLES, black hard serpentine, >6 cm, wet, fractured, no clay or weathered products.

BOTTOM OF BORING AT 13 FEET.



Well Permit No:
Date Well Drilled: December 16, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION



Approved by: [signature] RG 6568

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW328A *(page 1 of 1)*

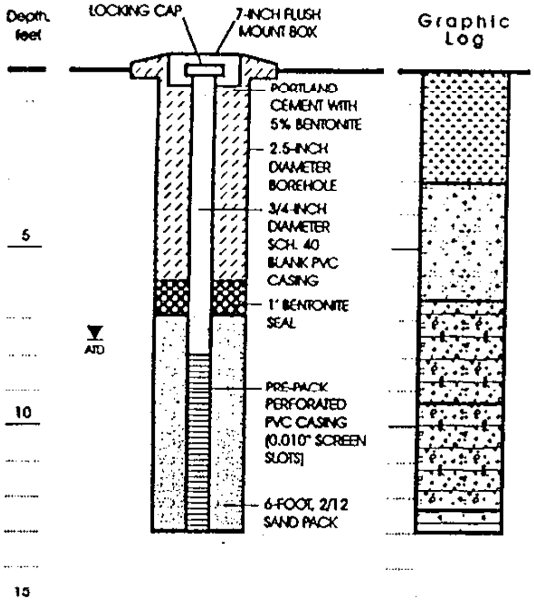
Levine·Fricke·Recon

Project No. 5109

Figur

5109L021.CDR 040398

WELL CONSTRUCTION	LITHOLOGY	SAMPLE DATA



Description

CONCRETE FLOOR.

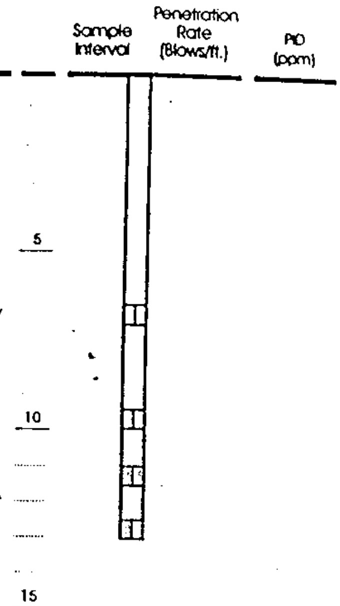
Hand Augered 3 to 5 foot.
GRAVELLY SANDS (SW), reddish yellow (5YR 7/6) 15% gravel up to 3 cm, slightly moist, minor silt.

CLAYEY GRAVEL (GC), FILL, decomposed serpentine, clay between fractures, black carbon specks up to 2 mm. Reddish clay specks up to 5 mm. Mostly greenish weathered serpentine.

Serpentine slightly weathered, dark blue, highly fractured, light blue clay along fractures. Slickenside on fracture surface.

GRAVELLY CLAY (CL), weathered serpentine, light greenish, highy fractured, talc clay, <5 cm hard serpentine in clay matrix slickenside on fracture ssurfaces.

BOTTOM OF BORING AT 13 FEET.



Well Permit No:	
Date Well Drilled:	December 15, 1997
Drilling Company:	Precision
Driller:	Sergio
Sampling Method:	Direct Push
Hammer Weight:	140 lbs.
LFR Geologist:	Roy Austin (The Enviro System Group)

EXPLANATION

Clay

Silt

Sand

Gravel

Interval sampled using Direct Push Sampler

Soil sample collected for analysis

Depth first water was encountered in borehole (ATD)

Approved by: [signature] RG 5568

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW329A *(page 1 of 1)*

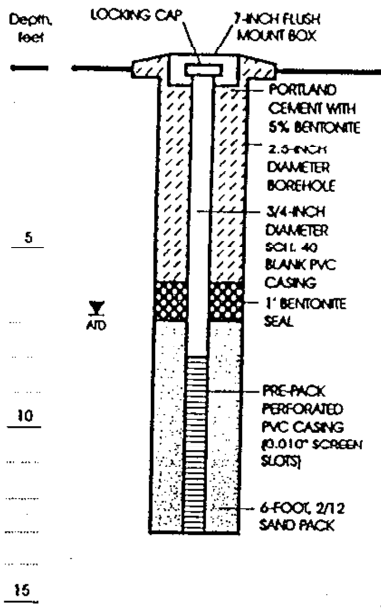
Levine·Fricke·Recon

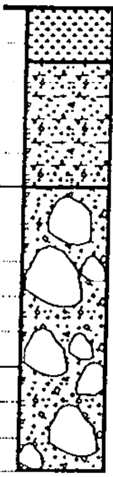
Project No. 5109

Figure

5109L022.CDR 040398

WELL CONSTRUCTION		LITHOLOGY	SAMPLE DATA		
Depth, feet	Graphic Log	Description	Sample Interval	Penetration Rate (Blows/ft.)	PID (ppm)





CONCRETE FLOOR 18".

Hand Augered to 4'.
SILTY GRAVEL (GM), serpentine, slightly moist, 80% < 1 cm, light greenish gray, minor clay and talc, slickensides.

COBBLES, black hard serpentine, dry, minor fractures, no weathering.

Highly weathered serpentine, slightly moist, soft, friable, light bluish green, (possible gouge) slickenside on all surfaces of fragments in ground matrix, talc present. Black, fractured, hard fragments.

BOTTOM OF BORING AT 13 FEET.

Well Permit No:
Date Well Drilled: December 16, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION

Clay
Silt
Sand
Gravel

Interval sampled using Push Point Sampler
Soil sample collected for analysis
ATD Depth first water was encountered in borehole

Approved by: [signature] RG 5546

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW330A *(page 1 of 1)*

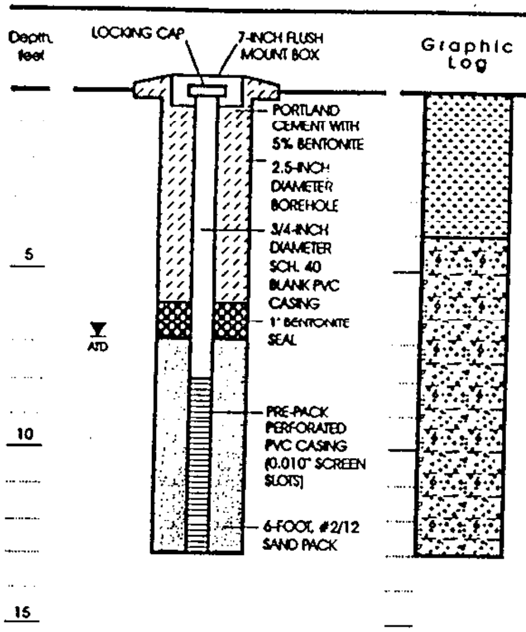
Levine-Fricke-Recon

Project No. 5109

Figure

5109L023.CDR 40398

WELL CONSTRUCTION	LITHOLOGY	SAMPLE DATA



Description

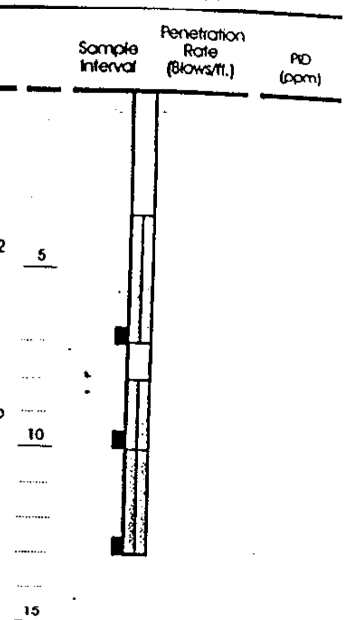
CONCRETE 4'.

SILTY GRAVEL (GM), serpentine, weathered, 10% clay, <2 cm rock fragments, moist, light greenish gray.
Serpentine, wet, black, <5 cm fragments, fractured.

Light greenish gray, trace brown clays, rock fragments to 4 cm in weathered matrix.

Highly fractured (<2 cm rock fragments), weathered to <10% clay, trace red clay, minor talc, slickensides on fracture surface.

BOTTOM OF BORING AT 13 FEET.



Well Permit No:
Date Well Drilled: December 15, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION

- Clay
- Silt
- Sand
- Gravel
- Interval sampled using Push Point Sampler
- Soil sample collected for analysis
- ATD Depth first water was encountered in borehole

Approved by: RG 6564

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW331A *(page 1 of 1)*

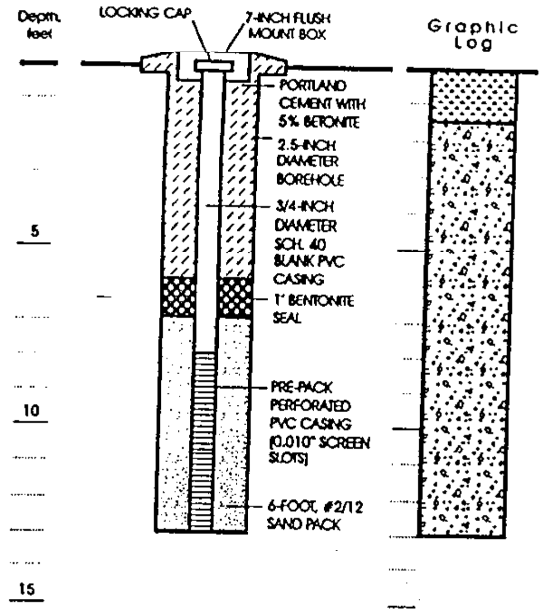
Levine·Fricke·Recon

Project No. 5109

Figure

5109L024.CDR 040398

WELL CONSTRUCTION | LITHOLOGY | SAMPLE DATA



Description

CONCRETE FLOOR, 14" THICK.

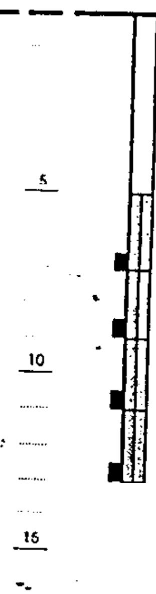
Hand augered to 5'.
GRAVELLY SILT (ML), slightly moist, light greenish gray mottled, 15% reddish brown, 75% silt, 25% weathered serpentine up to 2".

20% gravel, light greenish gray, minor red brown spots <1 mm.

40% _ravel, light greenish gray.

GRAVEL (GP), fractured serpentine cobbles, wet, black, calcite along fractures, no silts or clay.

BOTTOM OF BORING AT 13 FEET.



Well Permit No:
Date Well Drilled:
Drilling Company:
Driller:
Sampling Method:
Hammer Weight:
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION

- Clay
- Silt
- Sand
- Gravel
- Interval sampled using Push Point Sampler
- Soil sample collected for analysis
- Depth first water was encountered in borehole

Approved by: RG6568

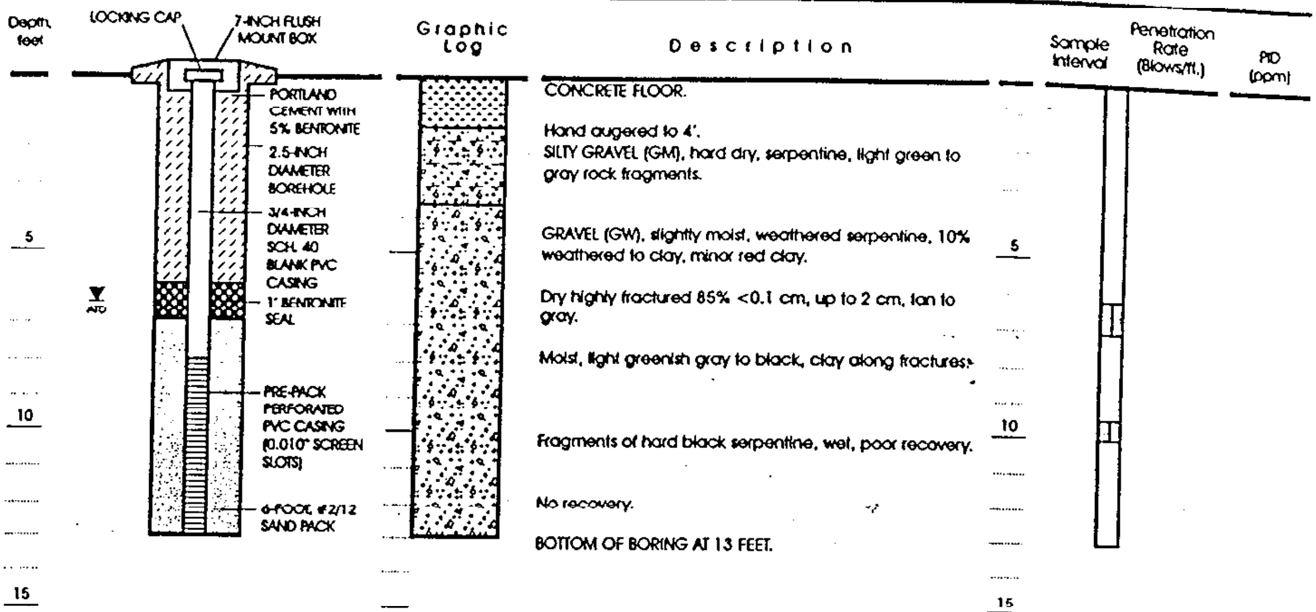
WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW333A (page 1 of 1)

Levine·Fricke·Recon
Project No. 5109

Figure

5109L026.CDR 040398

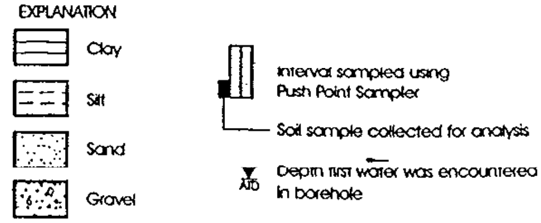
WELL CONSTRUCTION	LITHOLOGY	SAMPLE DATA



Depth (feet)	Description
0	CONCRETE FLOOR.
	Hand augered to 4'.
	SILTY GRAVEL (GM), hard dry, serpentine, light green to gray rock fragments.
5	GRAVEL (GW), slightly moist, weathered serpentine, 10% weathered to clay, minor red clay.
	Dry highly fractured 85% <0.1 cm, up to 2 cm, tan to gray.
	Moist, light greenish gray to black, clay along fractures.
10	Fragments of hard black serpentine, wet, poor recovery.
	No recovery.
	BOTTOM OF BORING AT 13 FEET.
15	

Well Permit No:
Date Well Drilled: December 15, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION



Approved by: [signature] RG 6568

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW334A *(page 1 of 1)*

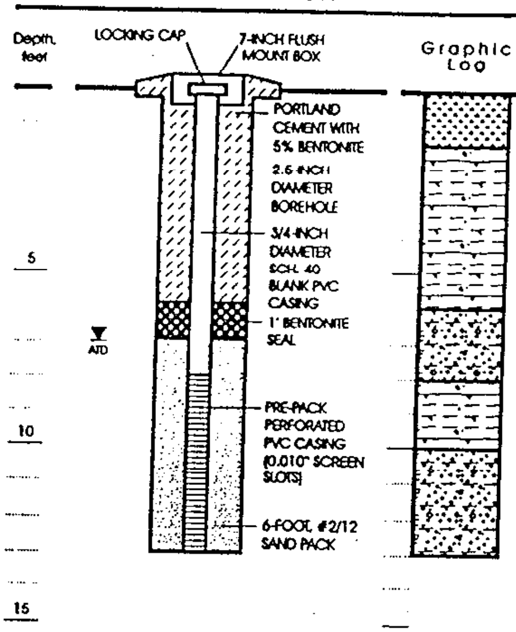
Levine·Fricke·Recon

Project No. 5109

Figure

5109L027.CDR 040398

WELL CONSTRUCTION | LITHOLOGY | SAMPLE DATA



Description	Depth	Sample Interval	Penetration Rate (Blows/ft.)	PID (ppm)
CONCRETE FLOOR.				
Hand augered to 5'.				
GRAVELLY SILT (ML), weathered serpentinite, 20% gravel up to 3", slightly moist, light greenish gray.	5			
SILTY GRAVEL (GM), fractured, wet, black, serpentinite, 20% silt.				
GRAVELLY SILT (ML), moist, light greenish gray, 25% <1 cm weathered serpentinite.	10			
SILTY GRAVEL (GM), weathered serpentine, wet, light greenish gray, 40% silts, 60% fragments.				
Fractured serpentinite, black, minor silts, no clays or talc.				
BOTTOM OF BORING AT 13 FEET.	15			

Well Permit No:
Date Well Drilled: December 17, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION

Clay
Silt
Sand
Gravel

Interval sampled using Push Point Sampler
Soil sample collected for analysis
ATD Depth first water was encountered in borehole

Approved by: [signature] RG 4561

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW335A (page 1 of 1)

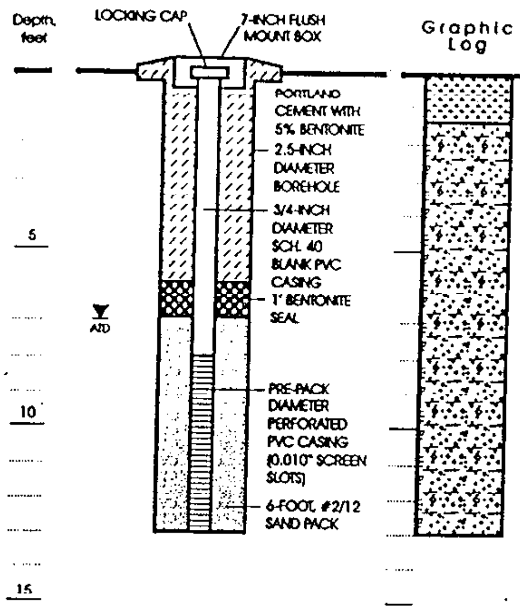
Levine·Fricke·Recon

Project No. 5109

Figure

5109L028.CDR 040398

WELL CONSTRUCTION	LITHOLOGY	SAMPLE DATA



Description

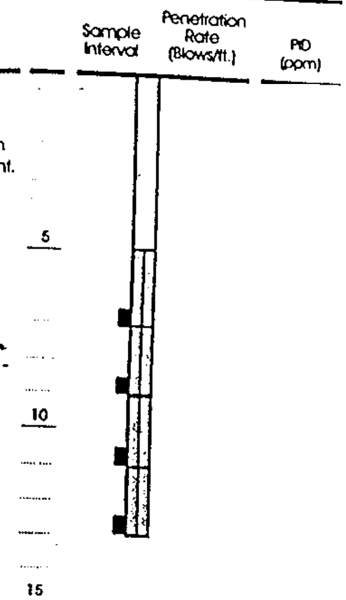
CONCRETE FLOOR. 18" THICK.

Hand augered to 4.5'.
SILTY GRAVEL (GM), weathered serpentine, light greenish gray, slightly moist, minor clay and talc, cobbles present.

Highly fractured gravel <2 cm.
Gravel <1 cm, minor brown clay in light green matrix.

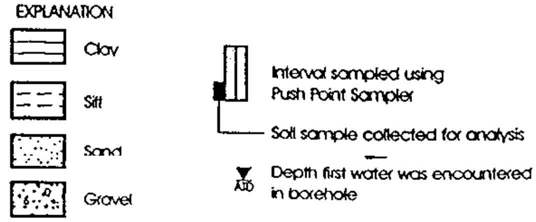
Serpentine, black, hard, highly fractured, <1 cm, slickenside, no clay or talc.
Weathered serpentine, wet, light greenish gray, with brown mottles, clay in fractures, predominantly hard black serpentine.

BOTTOM OF BORING AT 13 FEET.



Well Permit No:
Date Well Drilled: December 16, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION



Approved by: [signature] RG6561

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW336A *(page 1 of 1)*

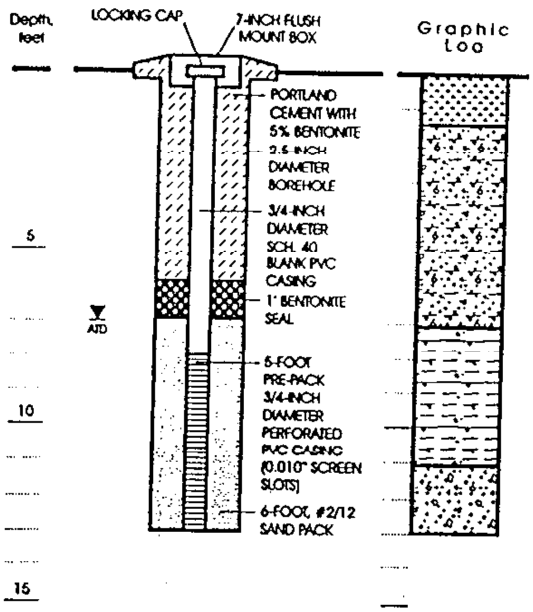
Levine-Fricke-Recon

Project No. 5109

Figure

5109L029.CDR 040398

WELL CONSTRUCTION | LITHOLOGY | SAMPLE DATA



Description

CONCRETE FLOOR, 18" THICK.

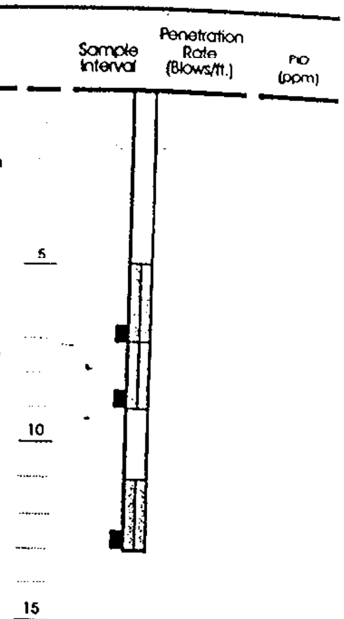
Hand augered to 5'.
SILTY GRAVEL (GM), weathered serpentine, light greenish gray, minor clay and talc, 8" cobble.

Slightly moist, minor brown clay, soft, 40% silt, slickensides.

GRAVELLY SILT (GM), weathered serpentine, slightly moist, light greenish gary, slickensides, fractured, minor clay and talc, 85% silt.

GRAVEL (GW), serpentine, wet, black, fractured, minor bluish greenish gray clay along fractures.

BOTTOM OF BORING AT 13 FEET.



Well Permit No:
Date Well Drilled: December 16, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION

- Clay
- Silt
- Sand
- Gravel
- Interval sampled using Push Point Sampler
- Soil sample collected for analysis
- ATD Depth first water was encountered in borehole

Approved by: [signature] RG 5565

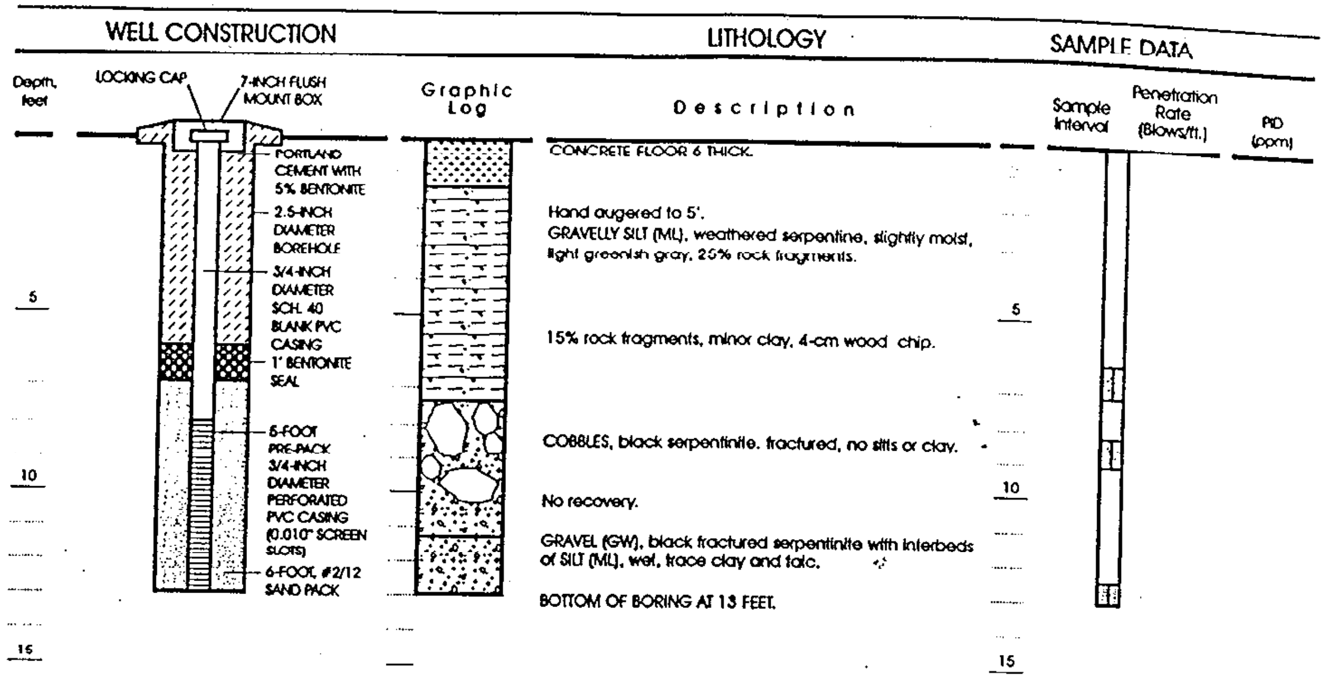
WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW337A *(page 1 of 1)*

Levine·Fricke·Recon

Project No. 5109

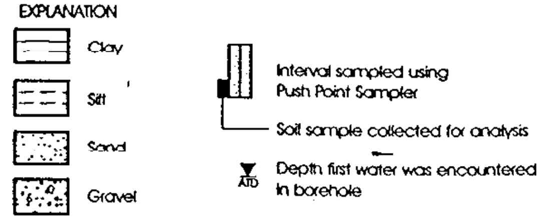
Figure

5109L030.CDR 040398



Well Permit No:	
Date Well Drilled:	December 17, 1997
Drilling Company:	Precision
Driller:	Sergio
Sampling Method:	Push Point
Hammer Weight:	140 lbs.
LFR Geologist:	Roy Austin (The Enviro System Group)

EXPLANATION



Approved by: Todd A. Miller RG6568

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW338A (page 1 of 1)

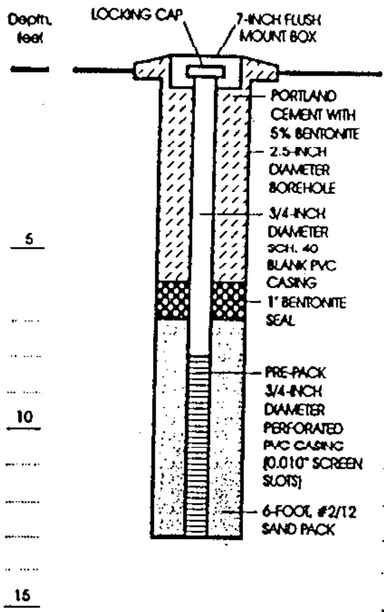
Levine·Fricke·Recon

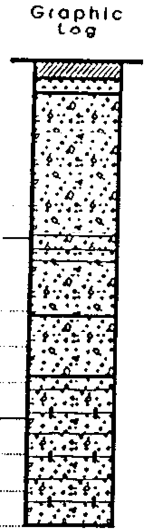
Project No. 5109

Figure

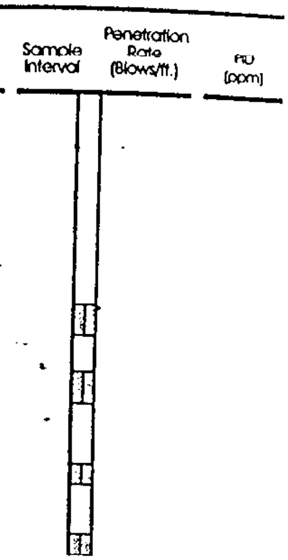
5109L031.CDR 040398

WELL CONSTRUCTION | LITHOLOGY | SAMPLE DATA





Depth (feet)	Description
0	ASPHALT 2" THICK.
	BASE ROCK 2" THICK, up to 6 cm angular, fill.
	GRAVEL (GW), weathered serpentine, up to 4". Slightly moist, light greenish gray, minor clay and talc, slickensides.
5	Minor red clay.
	GRAVEL (GW), 4" serpentinite, dry, grayish black, hard, fractured, calcite, stringers, <0.1 cm.
10	CLAYEY GRAVEL (GC), weathered serpentine, slightly moist, 70% <1 cm rock fragments, 30% light greenish clay.
	Wet, 20% clay.
	BOTTOM OF BORING AT 13 FEET.
15	



Well Permit No:
Date Well Drilled: December 17, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION

Clay

Silt

Sand

Gravel

Interval sampled using Push Point Sampler

Soil sample collected for analysis

ATD Depth first water was encountered in borehole

Approved by: Todd A. Miller RG 6566

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW339A (page 1 of 1)

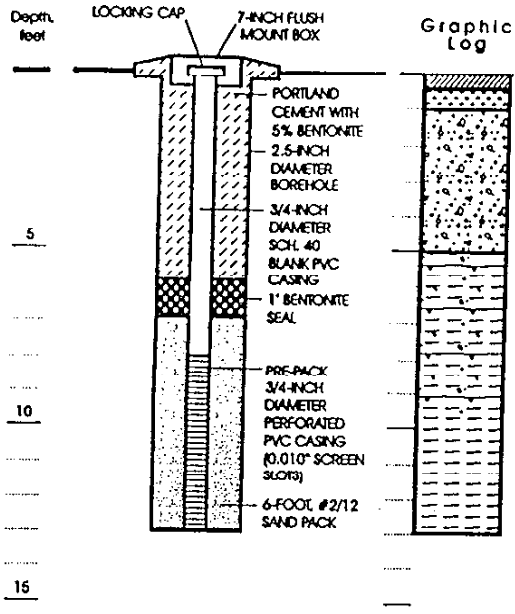
Levine·Fricke·Recon

Project No. 5109

Figure

5109L032.CDR 040398

WELL CONSTRUCTION	LITHOLOGY	SAMPLE DATA



Description

ASPHALT 2".

Base rock 2". Red base rock up to 3" angular gravel.

GRAVEL (GW), slightly moist, light greenish gray, 70% gravel and cobbles up to 4", 30% weathered serpentine, trace clay and talc.

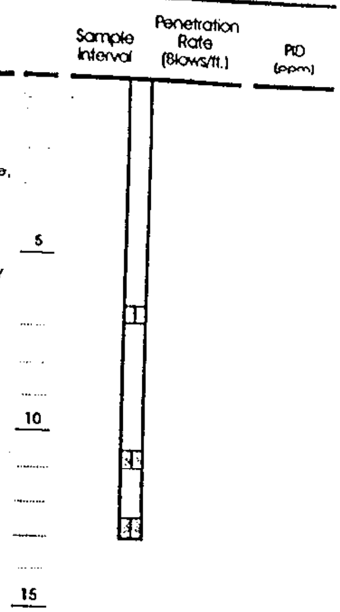
GRAVELLY CLAYEY SILT (ML), weathered serpentine, slightly moist, light greenish gray, 80% silt, 10% clay, 10% fine gravel, minor red clay.

No recovery.

SILT (ML), weathered serpentine, light greenish gray to grayish black, 70% silt, 30% fine gravel, trace clay and talc.

Weathered serpentine.

BOTTOM OF BORING AT 13 FEET.



Well Permit No:
Date Well Drilled: December 17, 1997
Drilling Company: Precision
Driller: Sergio
Sampling Method: Push Point
Hammer Weight: 140 lbs.
LFR Geologist: Roy Austin (The Enviro System Group)

EXPLANATION

Clay

Silt

Sand

Gravel

Interval sampled using Push Point Sampler

Soil sample collected for analysis

ATD Depth first water was encountered in borehole

Approved by: Todd A. Miller RG 6568

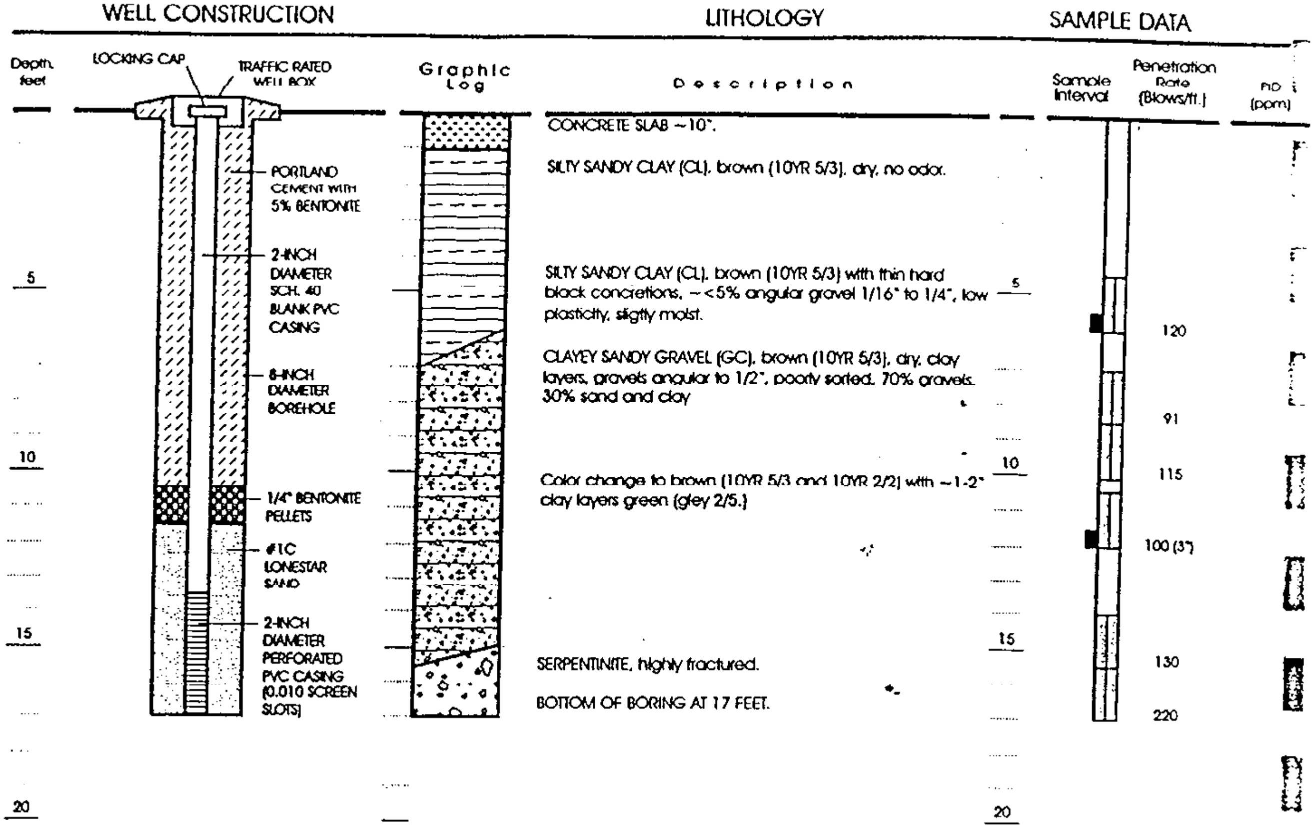
WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW340A *(page 1 of 1)*

Levine·Fricke·Recon

Project No. 5109

Figure

5109L033.CDR 040398



Well Permit No:	
Date Well Drilled:	December 16, 1997
Drilling Company:	West Hazmat
Driller:	Adam
Sampling Method:	Split Spoon
Hammer Weight:	140 lbs.
LFR Geologist:	David Houghton (Compliance and Closure)

EXPLANATION

Clay
Silt
Sand
Gravel

Interval sampled using Split Spoon Sampler
Soil sample collected for analysis
ATD Depth first water was encountered in borehole

Approved by: Todd A. Miller RG 6568

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW341F (page 1 of 1)

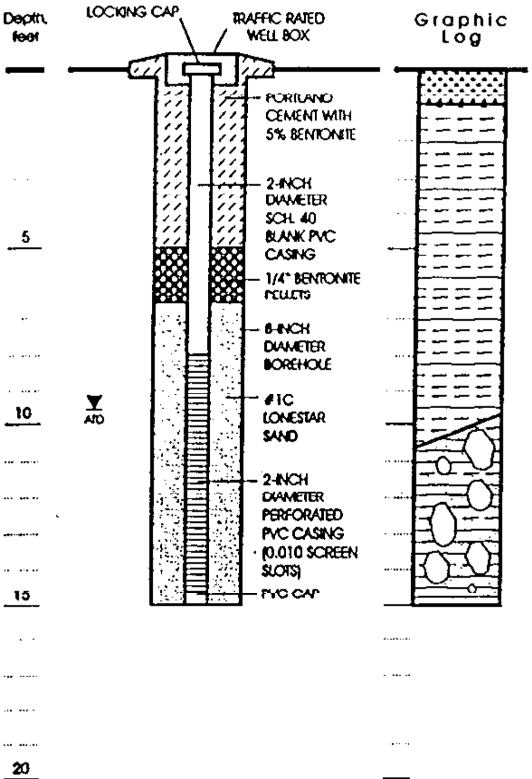
Levine·Fricke·Recon

Figure

Project No. 5109

5109L001.CDR 040398

WELL CONSTRUCTION	LITHOLOGY	SAMPLE DATA



Description

CONCRETE 10" SLAB.

SILTY SANDY CLAY (CL), dark yellowish brown (10YR 3/6), slight plasticity, dry, no odor, non radio-active, no organics.

SILTY SANDY CLAY (CL), dark grayish brown (10YR 4/2), with fractured angular gravels, 30% poorly sorted sand to 1/2" gravel.

BOULDERS, very dark gray (10YR 3/1), saturated decomposed serpintinite with 20% moderately plastic, sandy silty clay, brown (7.5YR 4/3).

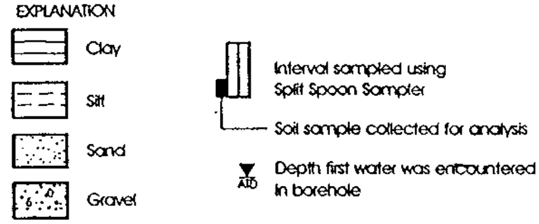
15' bottom very hard.

BOTTOM OF BORING AT 15 FEET.

Sample Interval	Penetration Rate (Blows/ft.)	PID (ppm)
	105	
	61	

Well Permit No:
Date Well Drilled: December 16, 1997
Drilling Company: West Hazmat
Driller: Adam
Sampling Method: Split Spoon
Hammer Weight: 140 lbs.
LFR Geologist: David Houghton (Compliance and Closure)

EXPLANATION



Approved by: [signature] RG 6568

WELL CONSTRUCTION AND LITHOLOGY FOR WELL IR28MW342F (page 1 of 1)

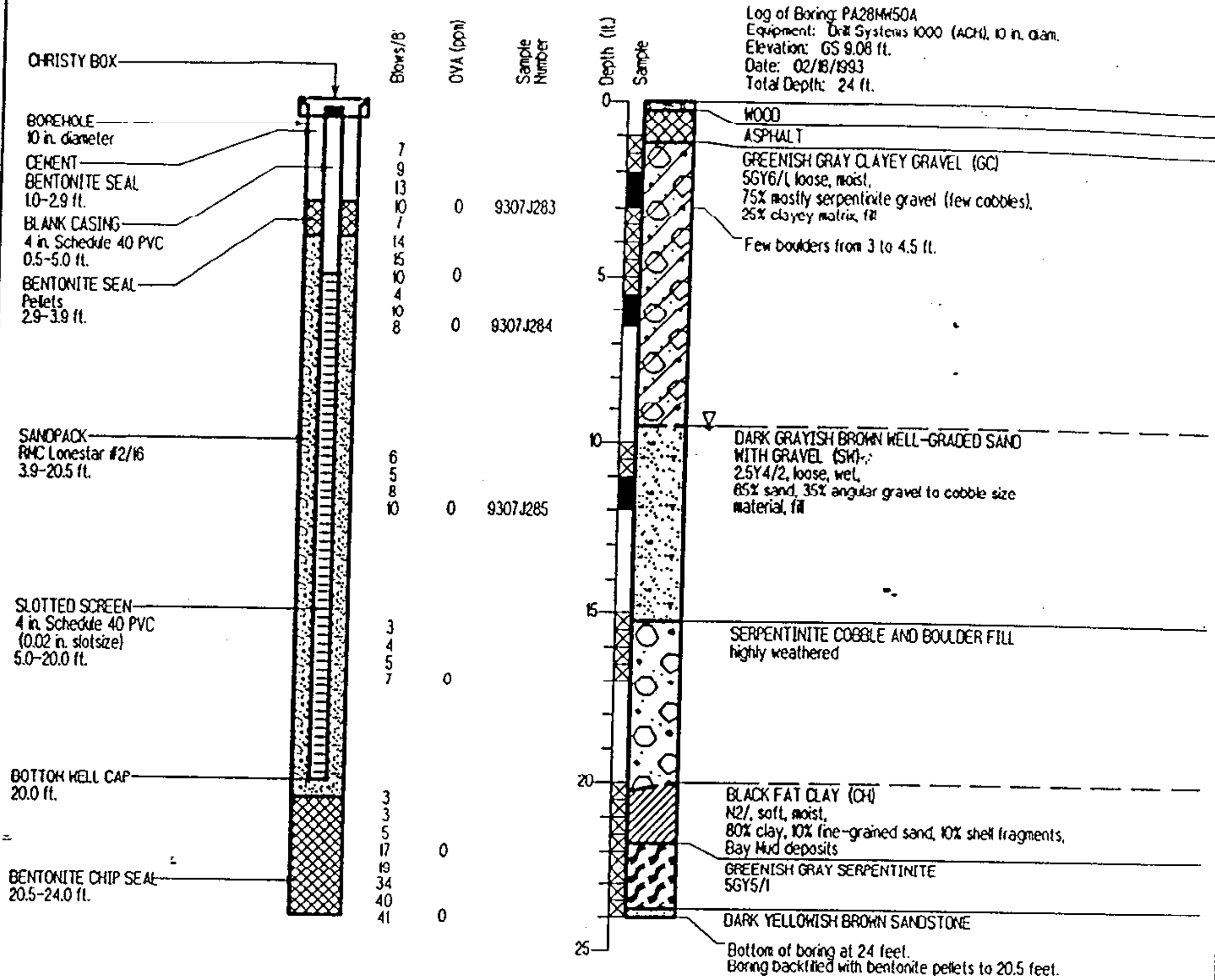
Levine·Fricke·Recon

Project No. 5109

Figure

5109L005.CDR 040398

Log of Boring: PA28MW50A
Equipment: Drill Systems 1000 (ACH), 10 in. diam.
Elevation: GS 9.08 ft.
Date: 02/18/1993
Total Depth: 24 ft.

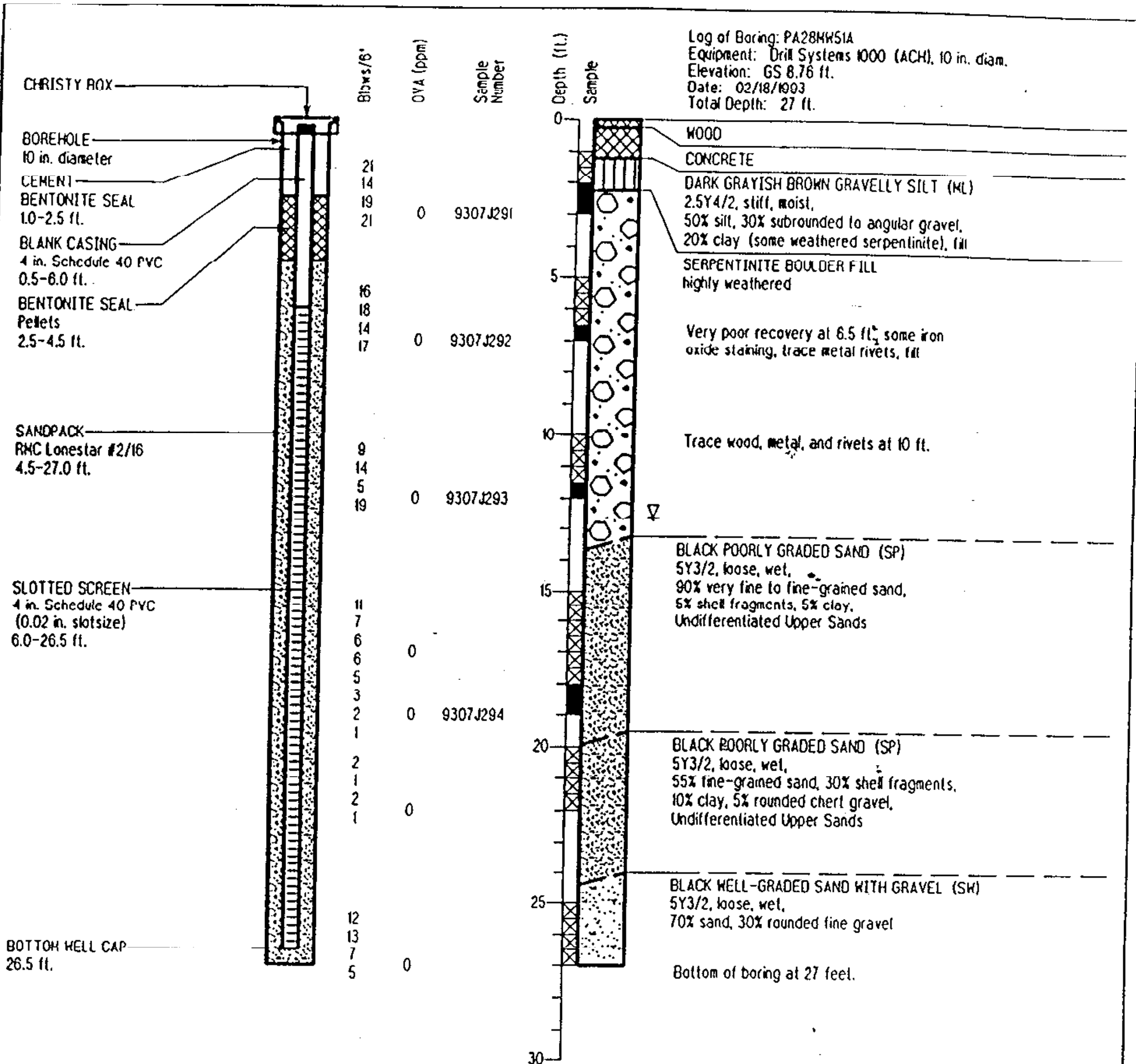


Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion PA28MW50A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 090405		11/93	

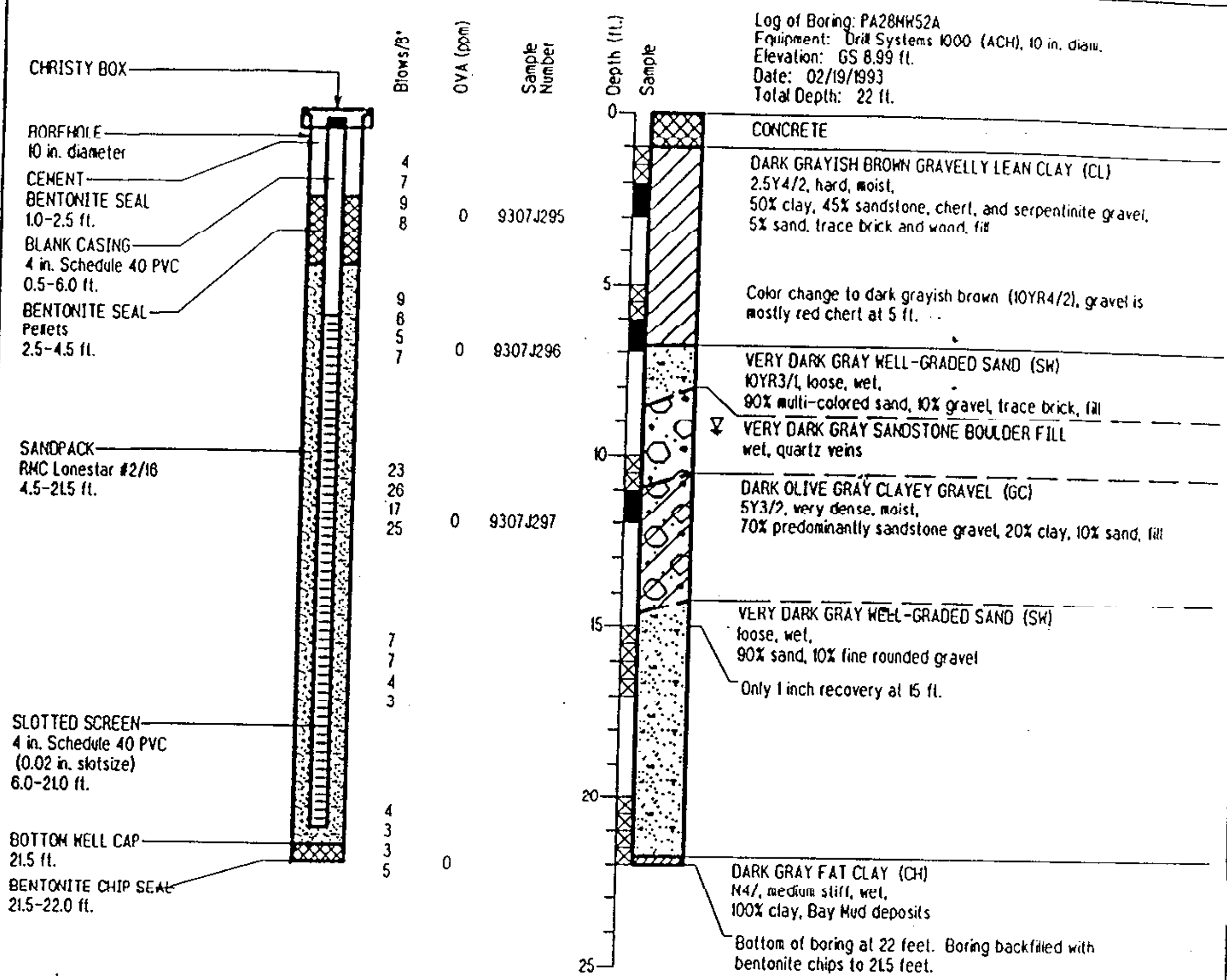


Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion PA28MW51A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
CLG	11400 090405		11/93	



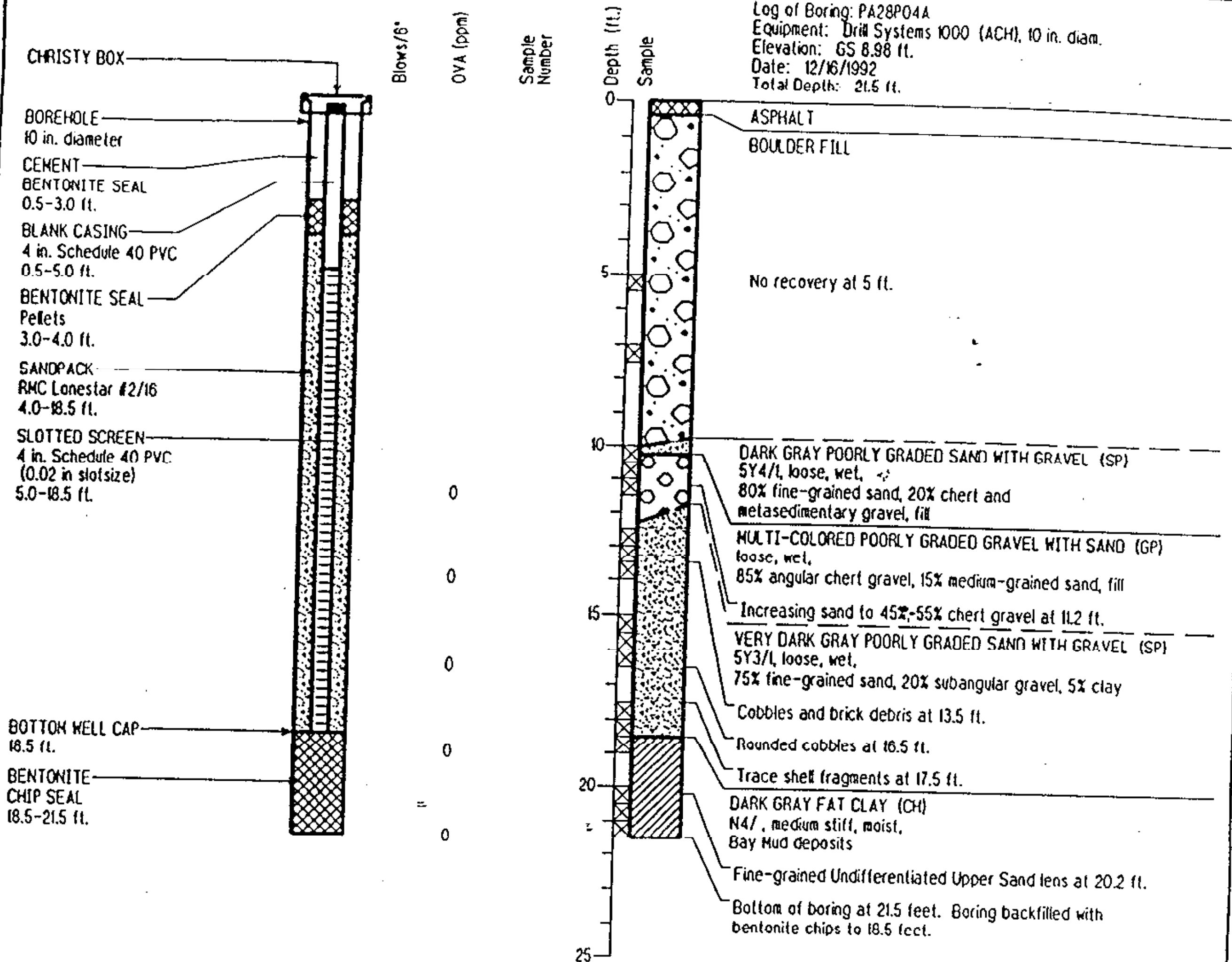
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion PA28MW52A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 090405		11/93	

Log of Boring: PA28P04A
Equipment: Drill Systems 1000 (ACH), 10 in. diam.
Elevation: GS 8.98 ft.
Date: 12/16/1992
Total Depth: 21.5 ft.



Harding Lawson Associates
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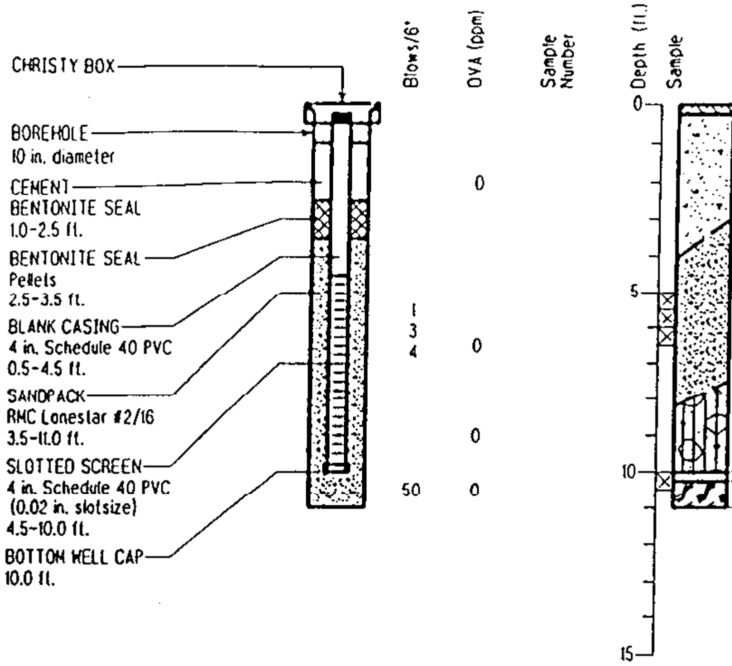
Environmental Services

Log of Boring and Well Completion PA28P04A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 090405		11/93	

Log of Boring. IR29MW48A
Equipment. Drill Tech DK-40 (ACH), 10 in. diam.
Elevation. GS 8.69 ft.
Date: 5/9/1994
Total Depth. 11 ft.



ASPHALT

DUSKY RED WELL-GRADED SAND WITH GRAVEL (SW)
10R3/2, dry,
60-65% chert sand, 35% chert gravel,
trace shell fragments, fill

Shell fragments and moisture increase
with depth

DARK YELLOWISH BROWN POORLY GRADED SAND (SP)
10YR4/4, loose, moist,
90% fine to medium sand, few shell fragments,
trace coarse sand and chert gravel, fill

DUSKY RED SILTY GRAVEL WITH SAND (GM)
2.5YR4/3,
40% chert gravel, 35% chert sand, 15% silt,
10% clay, fill

DUSKY RED WELL-GRADED SAND (SW)
2.5YR4/3, very dense, moist,
80% chert sand, 10% chert gravel,
5% silt, 5% clay, fill

GRAY SERPENTINITE (sp)
N5/, hard to very hard,
weak to moderately strong

Bottom of boring at 11 feet.

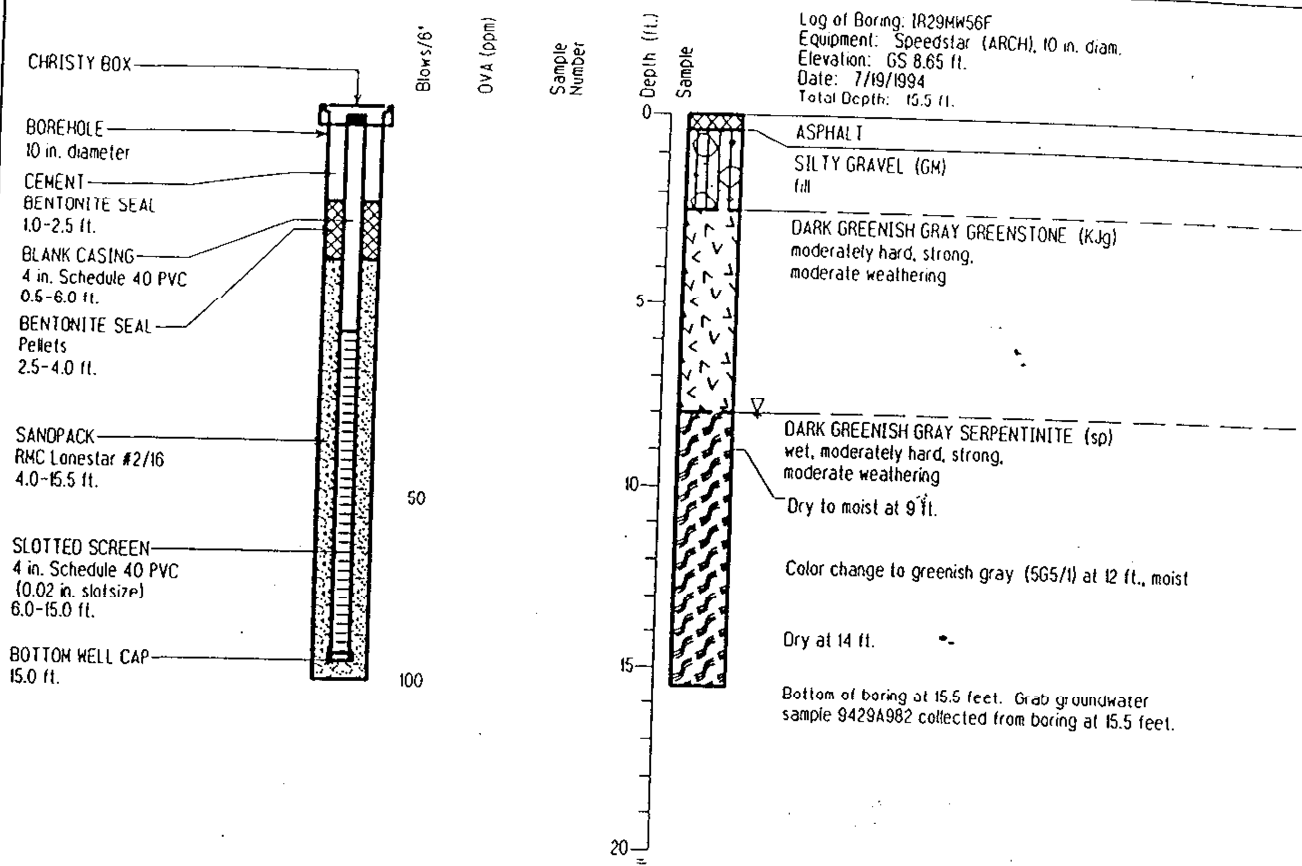
Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR28MW48A

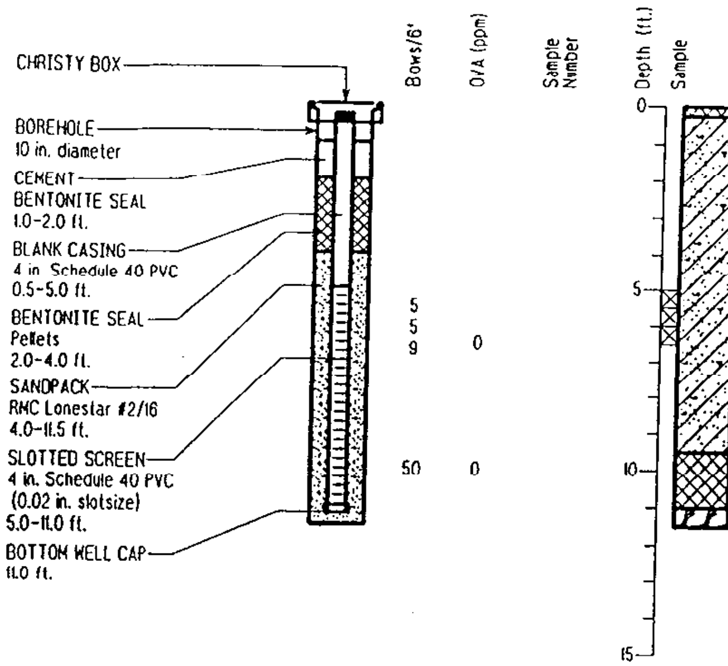
PLATE

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1410		08/94	



Harding Lawson Associates Engineering and Environmental Services	Log of Boring and Well Completion IR29MW56F Naval Station Treasure Island Hunters Point Annex San Francisco, California		PLATE
DRAWN: LRH	JOB NUMBER: 11400 1410	APPROVED	DATE: 05/95	REVISED DATE



Log of Boring: IR29MW57A
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation: GS 8.21 ft.
Date: 05/10/1994
Total Depth: 11.5 ft.

ASPHALT

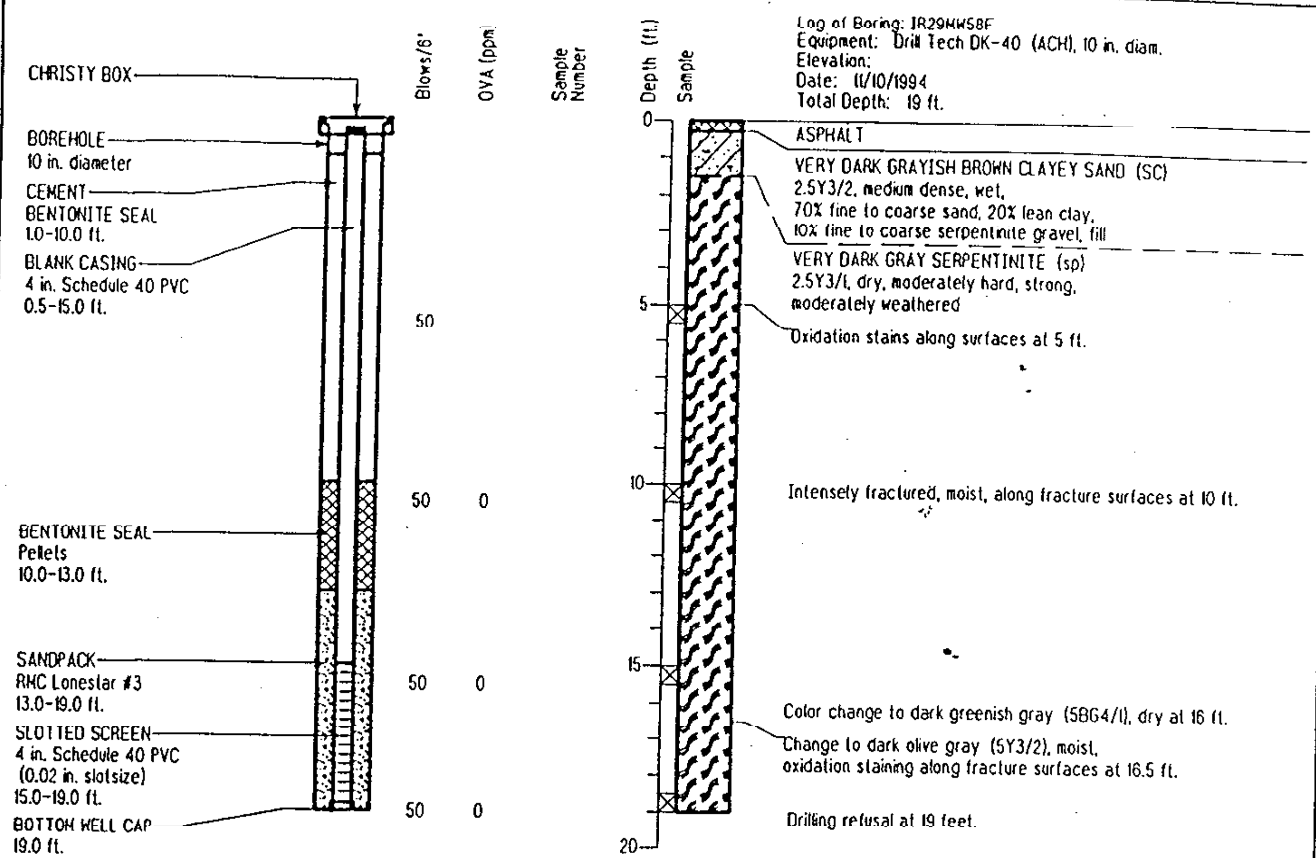
OLIVE GRAY CLAYEY SAND WITH GRAVEL (SC)
5Y4/1, medium dense, moist,
65% fine to coarse sand, 20% lean clay,
15% fine to coarse serpentinite gravel, fill

CONCRETE SLAB
no recovery, product present

DARK BLUISH GRAY SERPENTINITE (sp)
5BG4/1, dry, moderately hard,
strong, moderate weathering

Bottom of boring at 11.5 feet.

Harding Lawson Associates Engineering and Environmental Services	Log of Boring and Well Completion IR29MW57A Naval Station Treasure Island Hunters Point Annex San Francisco, California		PLATE
DRAWN: klr	JOB NUMBER: 11400 1410	APPROVED	DATE: 08/94	REVISED DATE



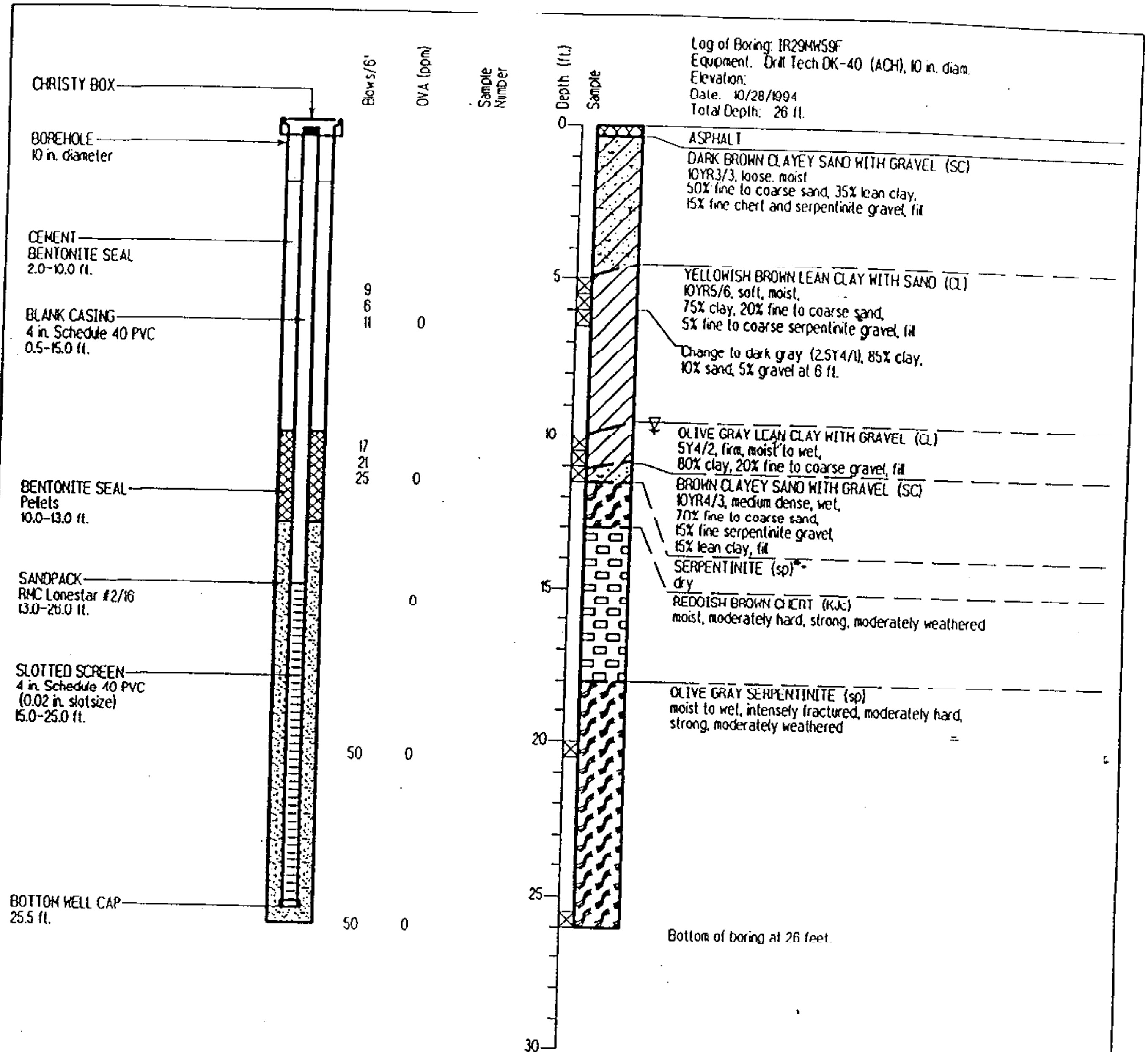
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR29MW58F

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1410		01/95	



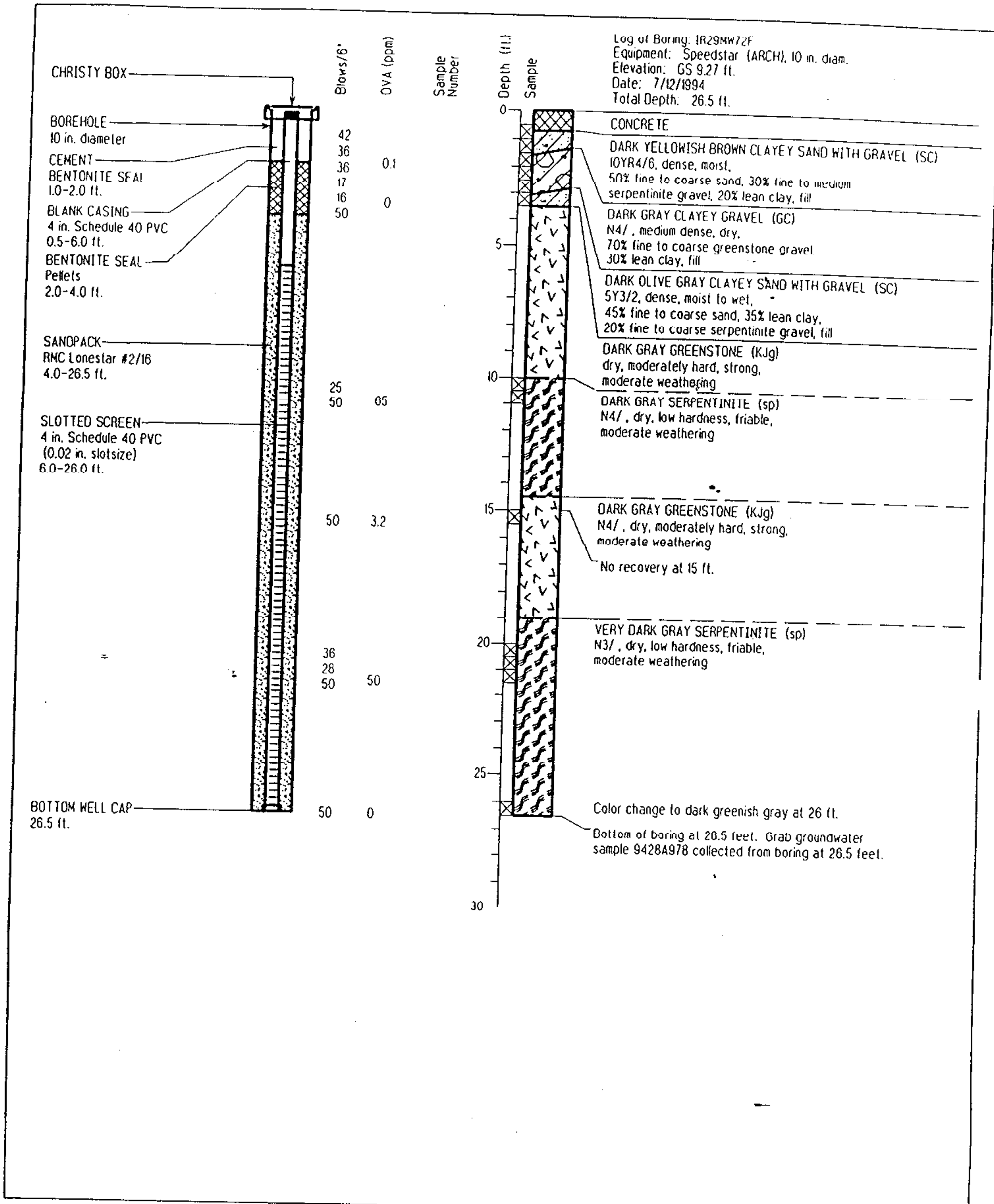
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR29MW59F

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1410		12/94	



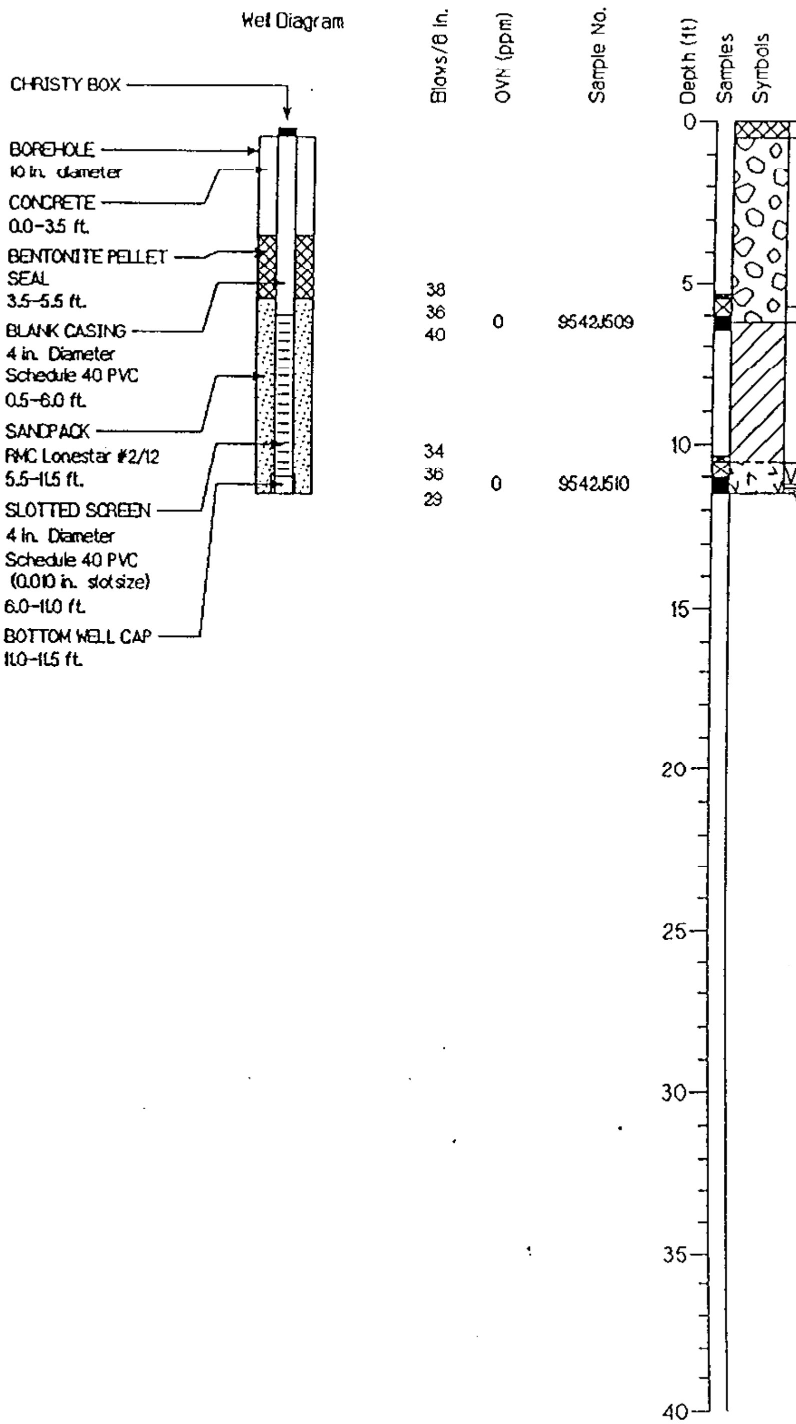
Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR29MW72F

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 1410		05/95	



Materials Description

ASPHALT

BROWN WELL-GRADED GRAVEL (GW)
7.5YR4/3, dense, dry, 90% gravel, 10% clay, fill

Color change to yellowish brown (10YR5/4) by 5 ft, 85% gravel, 15% fines

Color change to dark bluish gray (5B4/1) at 5.75 ft.

STRONG BROWN LEAN CLAY WITH GRAVEL (CL)
7.5YR5/6, dense, moist, 80% clay, 20% gravel, fill

GRAYISH GREEN GREENSTONE BEDROCK (KJg)
5G5/2, wet, closely fractured, hard, strong, fresh to little weathering

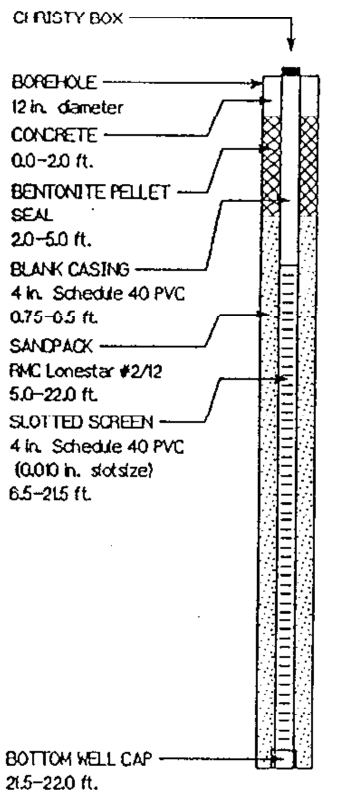
Bottom of boring at 11.5 feet.

Project Number: CTO 011	Date Drilled: 10/19/95
Project Name: Parcel C RI Report	GS Elevation: 8.83 ft.
Project Task: Hunters Point Shipyard	First Encountered Wet Soil: 11.25 ft.
Project Location: San Francisco, California	Total Depth Of Borehole: 11.5 ft.
Equipment: Air Casing Hammer Rig, 10 in. diam.	

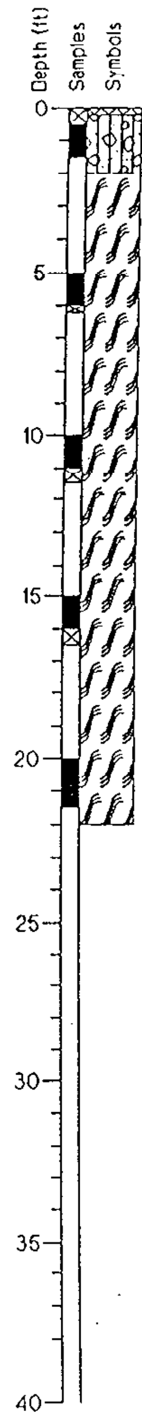
Figure

LOG OF BORING IR29MW85F

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.	Depth (ft)
3, 6, 10	0	9614J009	0
8, 12, 12	U	9614J010	5
10, 12, 15	0	9614J011	10
8, 12, 10	0	9614J012	15
8, 10, 12	0	9614J013 9614J014	20



Materials Description

ASPHALT

OLIVE SILTY GRAVEL WITH SAND (GM)
5Y4/4, dense, moist, 65% coarse serpentinite gravel, 20% silt, 15% medium to coarse sand, fill

Cuttings change to serpentinite bedrock at 2 ft.

BLACK SERPENTINITE BEDROCK (sp)
N2.5/, moist to dry, moderately hard, moderately to closely fractured, deeply weathered

Color change to pale green (5G6/2) at 16.25 ft.

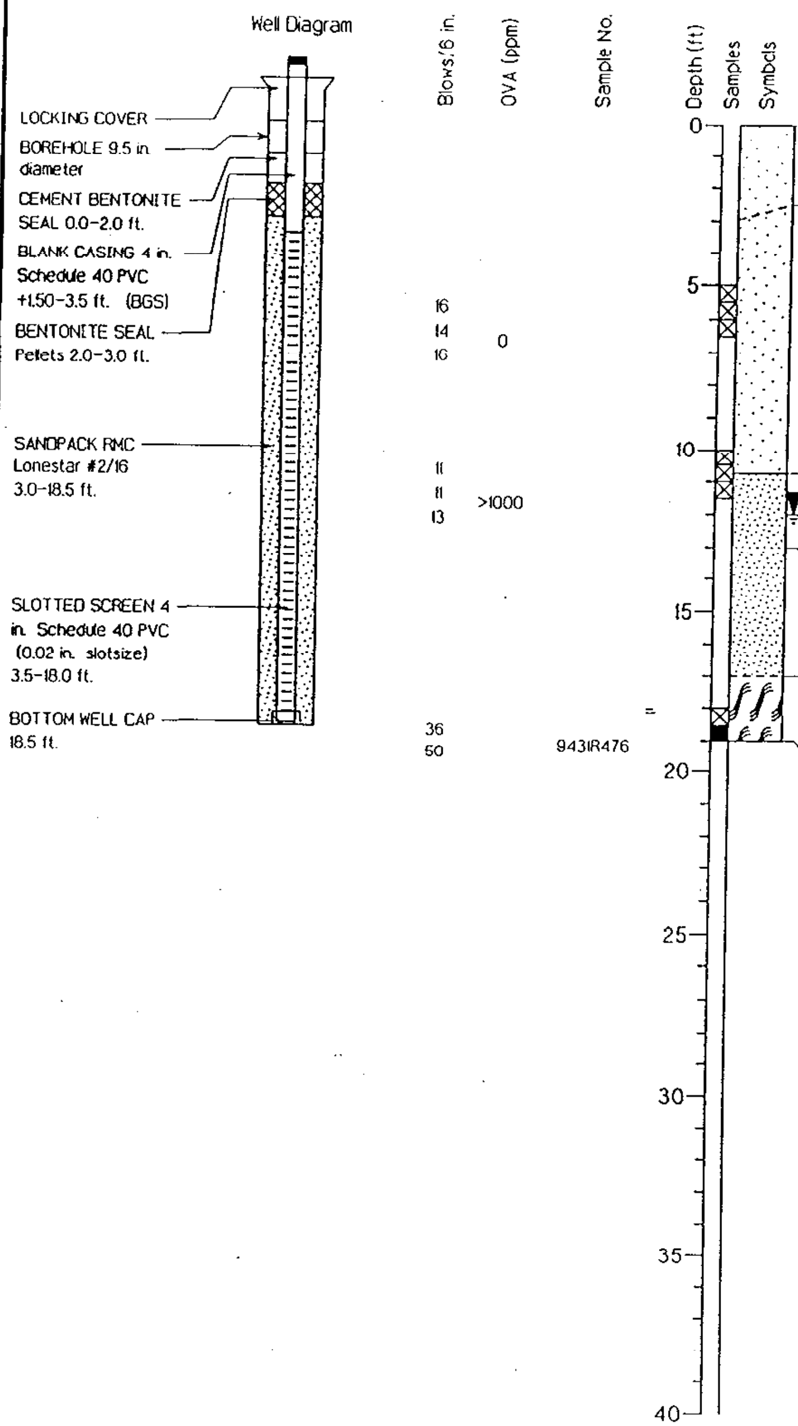
Bottom of boring at 22 feet.

Project Number: CTO 011	Date Drilled: 04/02/96
Project Name: Parcel C RI Report	GS Elevation: 10.19 ft.
Project Task: Hunters Point Shipyard	First Encountered Wet Soil: None Encountered
Project Location: San Francisco, California	Total Depth Of Borehole: 22 ft.
Equipment: Air Rotary Casing Hammer, 12 in. diam.	

Figure

PRC Environmental Management, Inc.
Adapted from Harding Lawson Associates

LOG OF BORING IR33MW61A



Blows/6 in.	OVA (ppm)	Sample No.
16		
14	0	
16		
11		
11	>1000	
13		
36		
50		9431R476

Materials Description

DARK GRAYISH BROWN WELL-[illegible] (SW) 10YR4/2, dense, dry, 60% fine to coarse sand, 40% fine gravel, fill

VERY DARK GRAYISH BROWN WELL-GRADED SAND WITH GRAVEL (SW) 10YR3/2, dense, moist, 70% fine to coarse sand, 30% fine gravel, abundant brick fragments, trace silt, fill

VERY DARK GRAY POORLY GRADED SAND (SP) N3/, dense, moist, 95% fine to medium sand, 5% silt, trace shell fragments, black plastic, fill

Water; sheen on cuttings at 12 ft.

Difficult drilling (concrete) at 13 ft.

BLACK SERPENTINITE (sp) N2.5/, dry, closely to intensely fractured, low hardness, friable to weak, deeply weathered

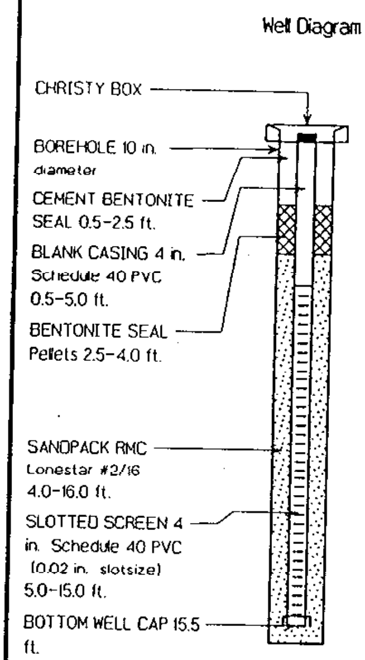
Bottom of boring at 19 feet.

Project Number	11400 1418	Date Drilled	8/1/1994
Project Name		GS Elevation	9.81 ft.
Project Task	Hunters Point Annex	Water Level	12 ft.
Project Location	San Francisco, California	Total Depth Of Hole	19 ft.
Equipment	Drill Tech DK-40 (ACH), 10 in. diam.		

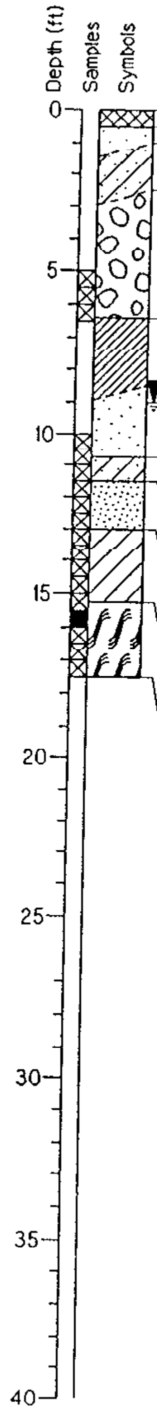
Figure

PRC Environmental Management, Inc.
Adapted from Harding Lawson Associates

LOG OF BORING IR33MW62A



Blows/6 in.	OVA (ppm)	Sample No.
7, 11, 4	0	
7, 12, 28	0	
10, 16, 19	0	
2, 3, 7	0	943IR485
26, 31, 38		
9, 11, 17		



Materials Description

ASPHALT

BROWN WELL-GRADED SAND (SW) 10YR4/3, very dense, dry, 90% fine to coarse sand, 10% fine gravel, fill

BLACK CLAYEY SAND (SC) 5Y2.5/1, dense, moist, 60% fine to coarse sand, 35% fat clay, 5% fine gravel, fill

DARK GRAY WELL-GRADED GRAVEL (GW) 5Y4/1, dense, dry, 90% fine to coarse serpentinite gravel, 10% fine to coarse sand, trace cobbles, fill

BLACK SANDY FAT CLAY WITH GRAVEL (CH) 5Y2.5/1, firm, moist, 70% clay, 15% fine to coarse sand, 15% fine gravel, fill

DARK OLIVE GRAY WELL-GRADED SAND WITH GRAVEL (SW) 5Y3/2, dense, wet, 75% fine to coarse sand, 25% gravel, fill

VERY DARK GRAY CLAYEY SAND (SC) N3/, dense, dry, 85% fine to coarse sand, 15% lean clay, fill

DARK BROWN POORLY GRADED SAND (SP) 10YR3/3, dense, wet, 85% fine to medium sand, 10% fine gravel, 5% silt, trace shell fragments, fill

DARK GRAY LEAN CLAY WITH GRAVEL (CL) 2.5Y4/1, firm, dry to moist, 80% clay, 15% fine serpentinite gravel, 5% fine to coarse serpentinite sand, fill

GRAYISH GREEN SERPENTINITE (sp) 5G5/2, dry, intensely fractured to crushed, low hardness, friable, deeply weathered

Bottom of boring at 17.5 feet

Project Number	11400 1418	Date Drilled	8/2/1994
Project Name		GS Elevation	8.19 ft.
Project Task	Hunters Point Annex	Water Level	9 ft.
Project Location	San Francisco, California	Total Depth Of Hole	17.5 ft.
Equipment	Drill Tech DK-40 (ACH), 10 in. diam.	Figure	

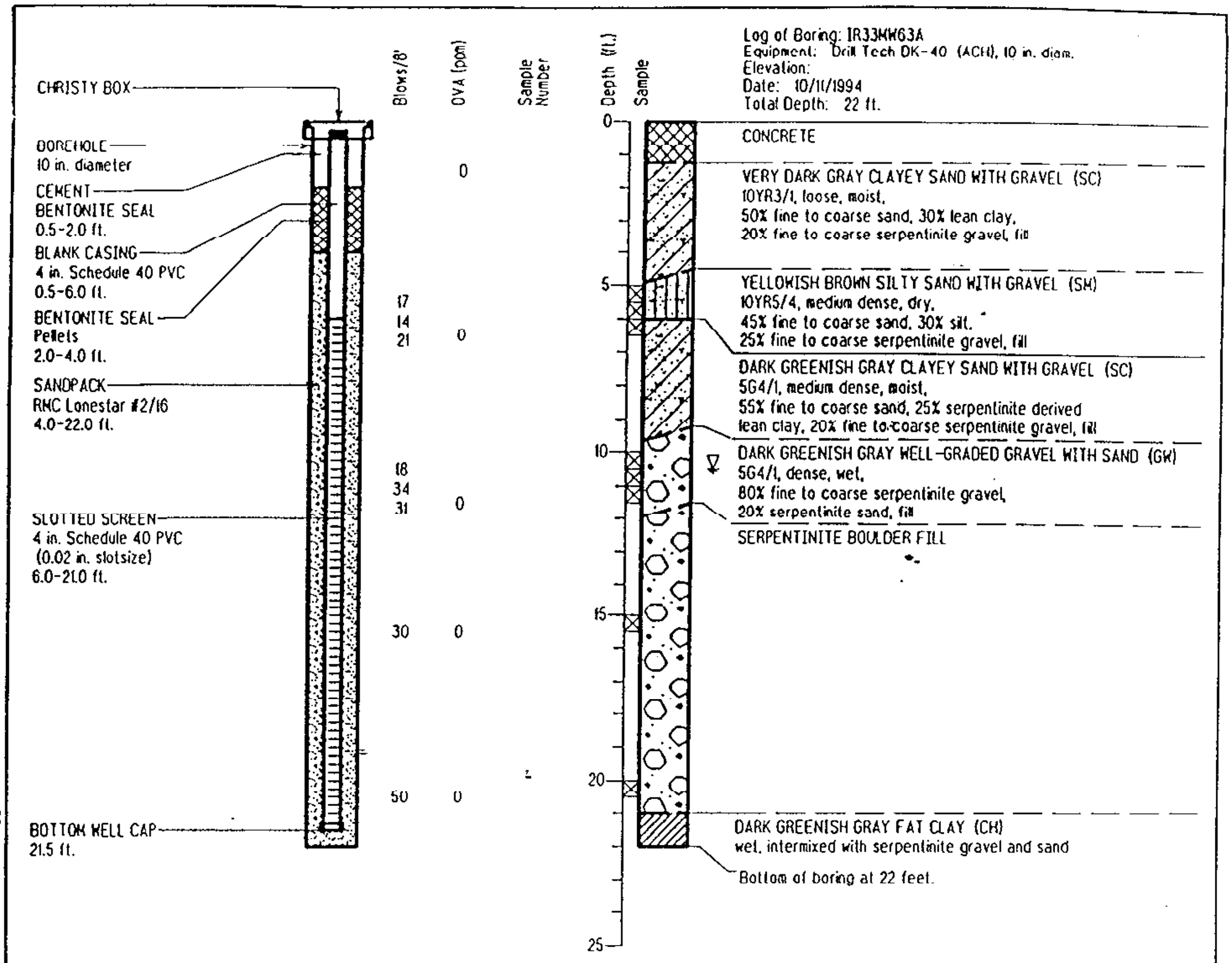
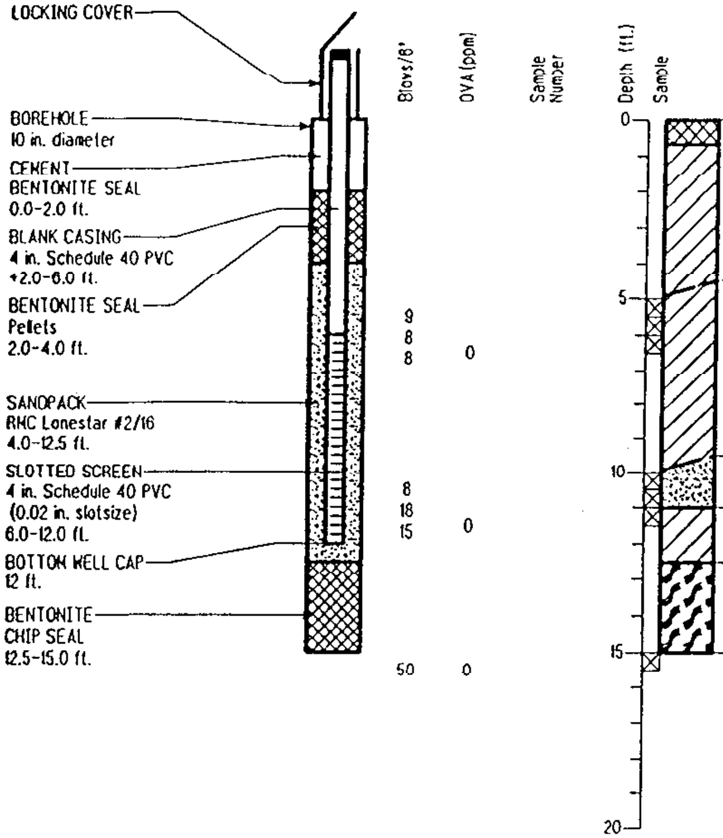


			PLATE
Harding Lawson Associates Engineering and Environmental Services		Log of Boring and Well Completion IR33MW63A Engineering Field Activity West Hunters Point Annex San Francisco, California	
DRAWN klr	JOB NUMBER 11400 1418	APPROVED	DATE 12/94	REVISED DATE

Log of Boring: IR33MW64A
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation:
Date: 10/19/1994
Total Depth: 15 ft.



CONCRETE

DARK YELLOWISH BROWN LEAN CLAY WITH SAND (CL)
10YR4/4, soft, moist,
80% clay, 15% fine to coarse sand,
5% fine serpentinite gravel, fill

YELLOWISH BROWN SANDY LEAN CLAY WITH GRAVEL (CL)
10YR5/4, soft, moist,
70% clay, 15% fine to coarse sand,
15% fine to coarse chert and serpentinite gravel, fill

DARK OLIVE GRAY POORLY GRADED SAND WITH GRAVEL (SP)
5Y3/2, loose, moist to wet,
85% fine to medium sand,
15% fine serpentinite gravel, fill

DARK GRAY LEAN CLAY (CL)
N4/, hard, moist,
95% serpentinite derived clay,
5% fine serpentinite gravel, fill

DARK GREENISH GRAY SERPENTINITE (sp)
5GG4/1, dry, very hard, strong,
moderately weathered

Bottom of boring at 15 feet.

Harding Lawson Associates
Engineering and
Environmental Services

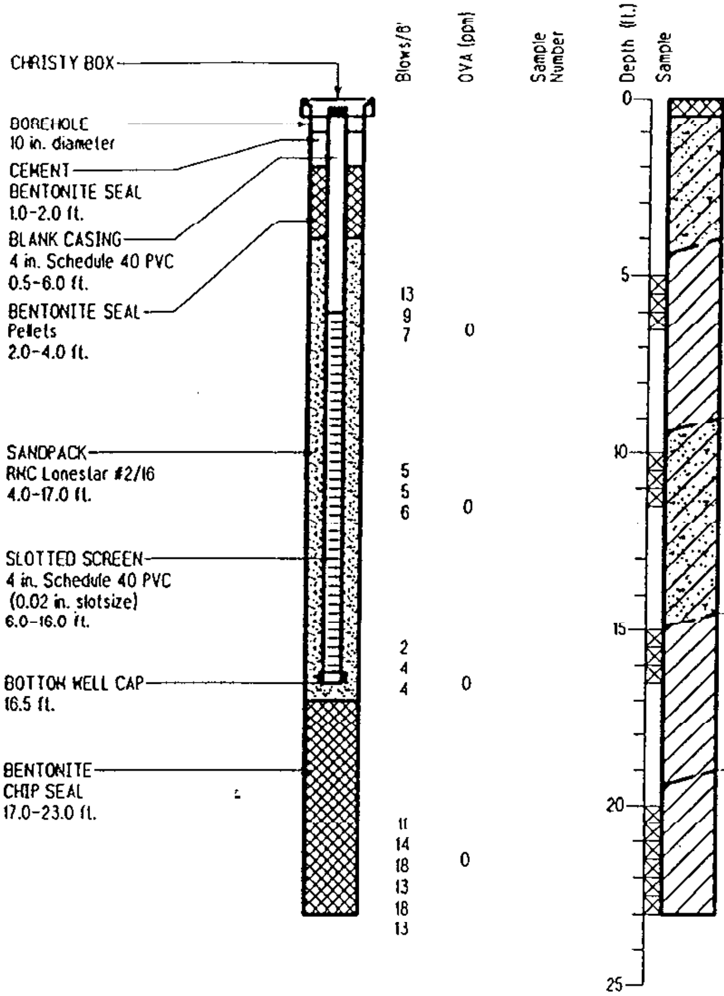
Log of Boring and Well Completion IR33MW64A

PLATE

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1418		12/94	

Log of Boring: IR33MW65A
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation:
Date: 10/06/1994
Total Depth: 23 ft.



ASPHALT

DARK YELLOWISH BROWN CLAYEY SAND WITH GRAVEL (SC)
10YR4/4, loose, moist,
65% fine to coarse sand, 20% lean clay,
15% fine to coarse chert and serpentinite gravel, fill

DARK BROWN SANDY LEAN CLAY (CL)
10YR4/4, firm to soft, moist,
50% clay, 40% fine to coarse sand,
10% fine to coarse chert and serpentinite gravel, fill

DARK GRAYISH BROWN CLAYEY SAND WITH GRAVEL (SC)
10YR4/2, loose, wet,
50% fine to coarse sand,
35% fine to coarse chert and serpentinite gravel,
15% lean clay, fill

DARK GRAY LEAN CLAY WITH SAND (CL)
5Y4/1, soft, moist,
85% clay, 10% fine to medium sand,
5% fine gravel, trace shell fragments, fill

VERY DARK GRAY LEAN CLAY (CL)
hard, dry to moist

Bottom of boring at 23 feet.

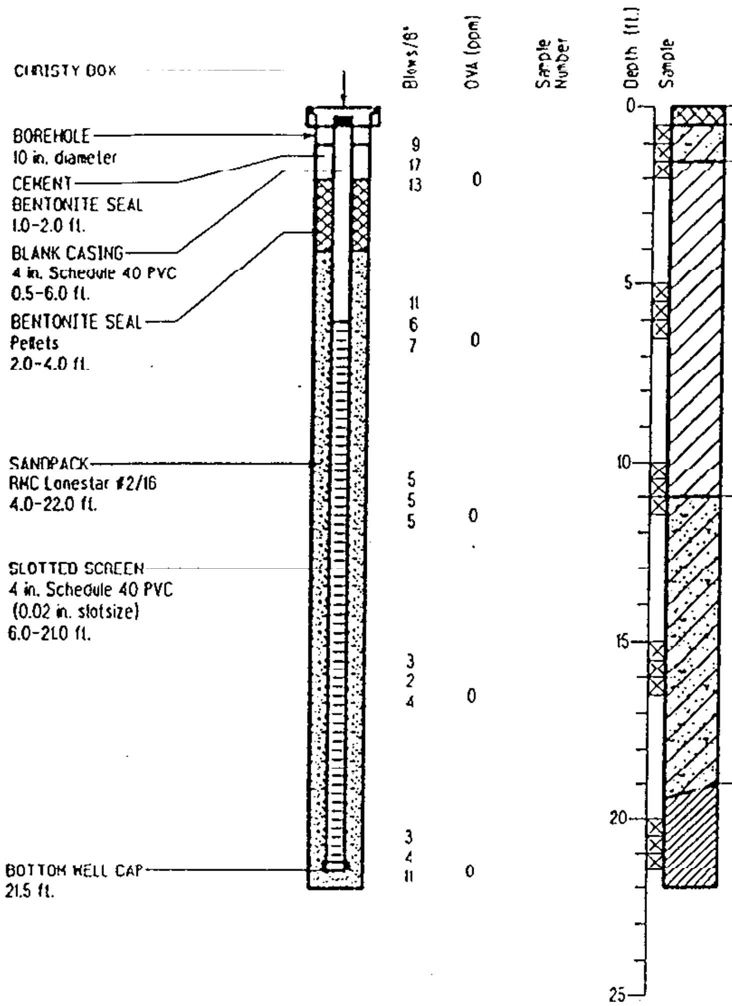
Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR33MW65A

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1418		12/94	



Log of Boring: IR33MW66A
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation.
Date. 10/07/1994
Total Depth. 22 ft.

ASPHALT

DARK REDDISH GRAY CLAYEY SAND (SC)
5YR4/2, medium dense, moist,
50% fine to coarse sand, 45% lean clay,
5% chert gravel, fill

DARK BROWN LEAN CLAY WITH SAND (CL)
7.5YR3/3, firm, moist,
80% clay, 20% fine to coarse sand, fill

DARK YELLOWISH BROWN CLAYEY SAND (SC)
10YR4/6, loose, wet,
65% fine to coarse sand, 30% lean clay,
5% fine to coarse serpentinite gravel, fill

Color change to dark gray (5Y4/1) at 15 ft.

GRAYISH BROWN FAT CLAY (CH)
10YR5/2, soft, moist,
95% clay, 5% fine serpentinite gravel

Bottom of boring at 22 feet.

Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR33MW66A

PLATE

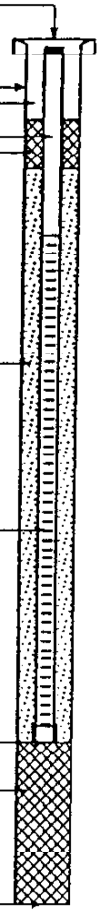
Engineering Field Activity West
Hunters Point Annex
San Francisco, California

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1418		12/94	

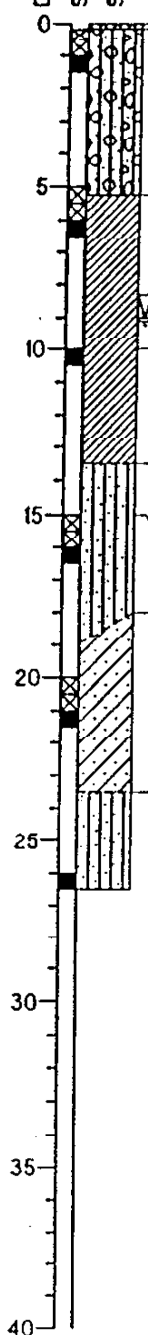
PRC Environmental Management, Inc.

LOG OF BORING IR33MW116A

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.	Depth (ft)
27, 27, 22	0.5	9531C061	0-1
5, 6, 7	1	9531C062	5-6
	1	9531C063	10
6, 8, 9	0	9531C065	15-16
5, 6, 7	0.5	9531C066	20-21
14, 17, 20	0.3	9531C067	25-26



Materials Description

ASPHALT

DARK YELLOWISH BROWN SILTY GRAVEL WITH SAND (GH) 10YR4/4, dense, dry, 70% fine to medium gravel, 15% sand, 15% silt, fill

GREENISH BLACK FAT CLAY WITH GRAVEL (CH) 5GY2.5/1, soft, dry, 85% clay, 15% gravel, fill

Wet at 9 ft.

Increasing sand content to 10% at 10 ft.

GREENISH BLACK SILTY SAND (SM) 10Y2.5/1, loose, wet, 75% fine sand, 20% silt, 5% shell fragments, undifferentiated upper sand deposits

Hydropunch groundwater sample 9531C064 collected from boring; screened from 15 to 17 ft.

DARK GREENISH GRAY CLAYEY SAND (SC) 10GY3/1, loose, wet, 60% fine sand, 15% clay, 15% silt, 10% shell fragments, undifferentiated upper sand deposits

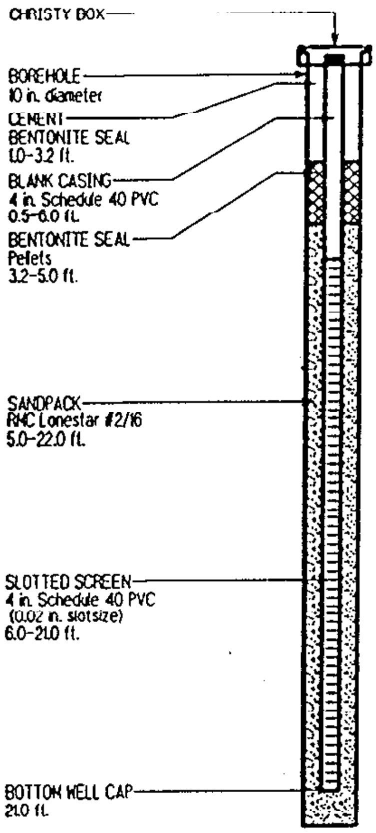
YELLOWISH BROWN SILTY SAND (SM) 10YR5/6, medium dense, wet, 75-80% poorly graded sand, 15% silt, 5-10% clay, undifferentiated sedimentary deposits

Bottom of boring at 26.5 feet. Boring backfilled with bentonite pellets from 21.5 to 26.5 feet.

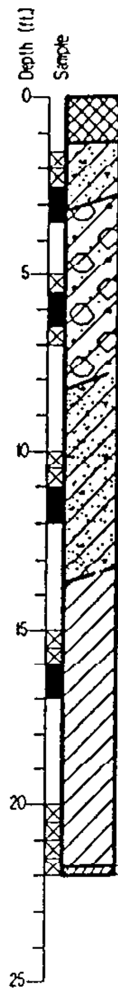
Project Number	CTO 5	Date Drilled	07/31/95
Project Name	Parcel D RI Report	GS Elevation	NA
Project Task	Hunters Point Annex	First Encountered Wet Soil	9 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	26.5 ft.
Equipment	Mobile Drill HDX 61 (HSA), 10 in. diam.		

Figure

Log of Boring: PA33MW36A
Equipment: Drill Systems 1000 (ACH), 10 in. diam.
Elevation: GS 9.66 ft.
Date: 03/02/1993
Total Depth: 22 ft.



Blows/6"	OVA (ppm)	Sample Number
3 3 3 4	0	9309A647
1 2 2 3	0	9309A648
3 3 2 5	0	9309A649
2 4 5 8	0	9309A650



CONCRETE

YELLOWISH BROWN CLAYEY SAND WITH GRAVEL (SC)
loose, wet,
65% medium- to coarse-grained sand, 20% fine subangular gravel, 15% lean clay, fill

DARK YELLOWISH BROWN CLAYEY GRAVEL WITH SAND (GC)
10YR3/4,
55% fine subangular gravel, 30% lean clay,
15% medium- to coarse-grained sand, fill

Color change to very dark grayish brown (10YR3/2) at 5 ft.

DARK YELLOWISH BROWN CLAYEY SAND WITH GRAVEL (SC)
10YR3/4, loose, moist to wet,
60% medium- to coarse-grained sand, 20% lean clay,
20% fine subrounded gravel, fill

DARK GRAY LEAN CLAY WITH SAND (CL)
N4/, soft, moist,
80% clay, 20% medium-grained sand, fill

DARK GREENISH GRAY FAT CLAY (CH)
soft, moist,
70% clay, 30% shell fragments, Bay Mud deposits

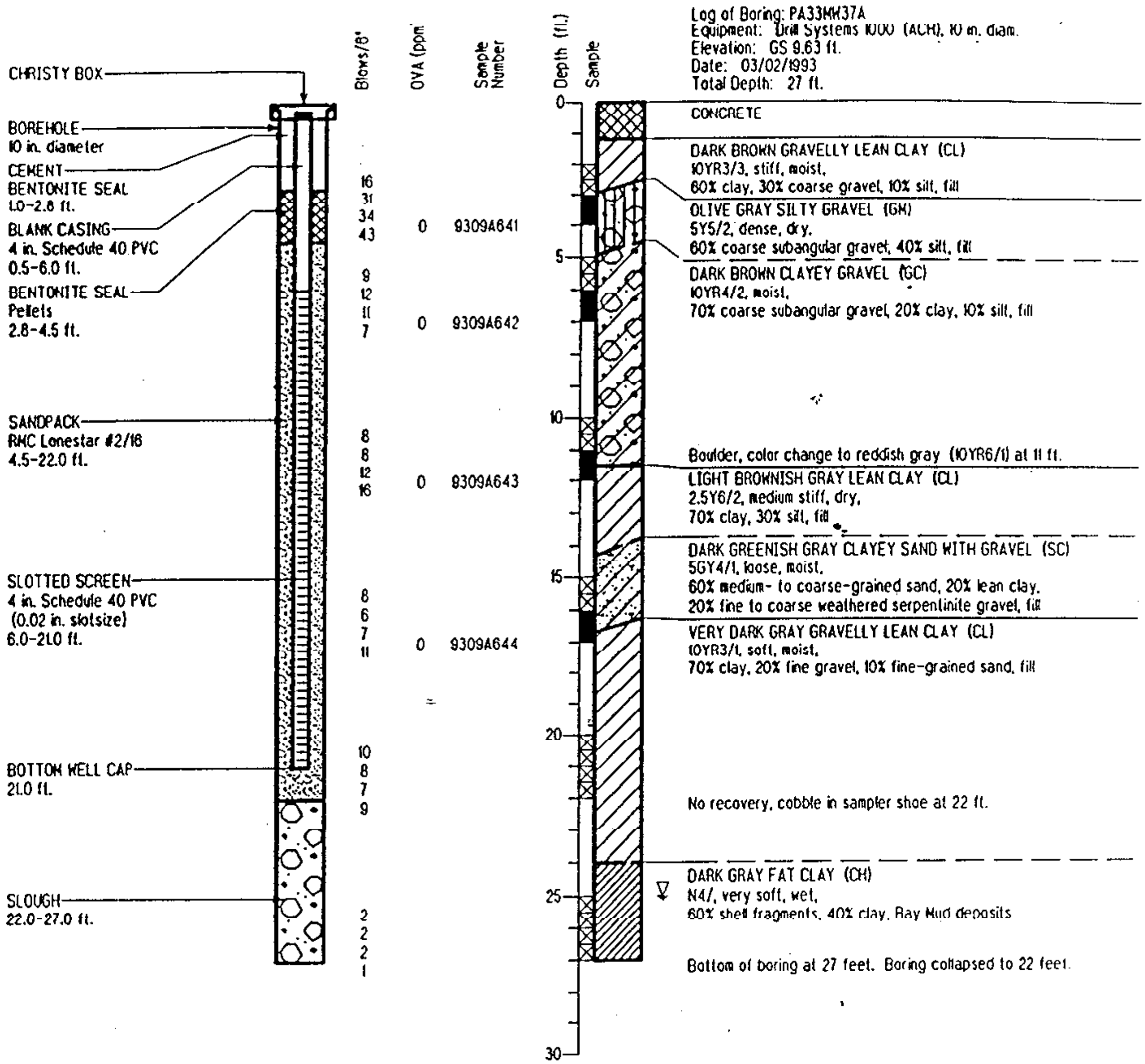
Bottom of boring at 22 feet.

Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion PA33MW36A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 090405		11/93	



Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion PA33MW37A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 090405		11/93	

Log of Boring: IR34MW01A
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation:
Date: 9/6/1994
Total Depth: 20 ft.

CHRISTY BOX

BOREHOLE
10 in. diameter

CEMENT
BENTONITE SEAL
1.0-1.8 ft.

BLANK CASING
4 in. Schedule 40 PVC
0.5-5.5 ft.

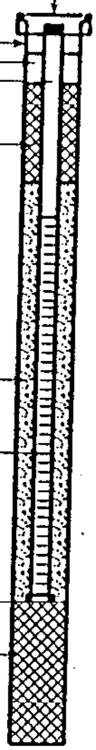
BENTONITE SEAL
Pellets
1.8-4.5 ft.

SANDPACK
RMC Lonestar #2/16
4.5-16.0 ft.

SLOTTED SCREEN
4 in. Schedule 40 PVC
(0.02 in. slotsize)
5.5-15.5 ft.

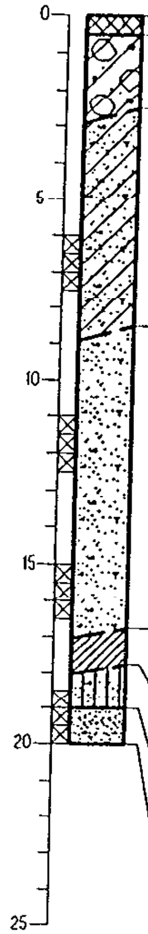
BOTTOM WELL CAP
16.0 ft.

BENTONITE
CHIP SEAL
16.0-20.0 ft.



Blows/6"	OVA (ppm)	Sample Number
6, 7, 11	0	
8, 9, 13	3.0	
10, 6, 6	0	
4, 21, 40	0	

Depth (ft.) | Sample



ASPHALT

YELLOWISH BROWN CLAYEY GRAVEL WITH SAND (GC)
10YR5/4, medium dense, moist,
60% fine to coarse graywacke and chert gravel,
25% lean clay, 15% fine to coarse sand, fill

YELLOWISH BROWN CLAYEY SAND WITH GRAVEL (SC)
10YR5/6, medium dense, moist,
60% fine to coarse sand, 25% lean clay,
15% fine to coarse chert, graywacke, and
serpentinite gravel, fill

YELLOWISH BROWN WELL-GRADED SAND WITH GRAVEL (SW)
10YR5/4, dense, wet,
70% fine to coarse chert and graywacke sand,
20% fine to coarse chert and graywacke gravel,
10% lean clay, fill

VERY DARK GRAY FAT CLAY (CH)
N3/ soft, wet,
80% clay, 10% silt, 10% fine sand,
trace shell fragments, Bay Mud deposits

DARK OLIVE GRAY SILTY SAND (SM)
5Y3/2, loose to medium dense, wet,
80% fine sand, 10% silt, 10% lean clay,
trace shell fragments, Bay Mud deposits

DARK YELLOWISH BROWN POORLY GRADED SAND (SP)
10YR3/6, very dense, wet,
100% fine sand, trace lean clay,
Undifferentiated Sedimentary deposits

Bottom of boring at 20 feet.

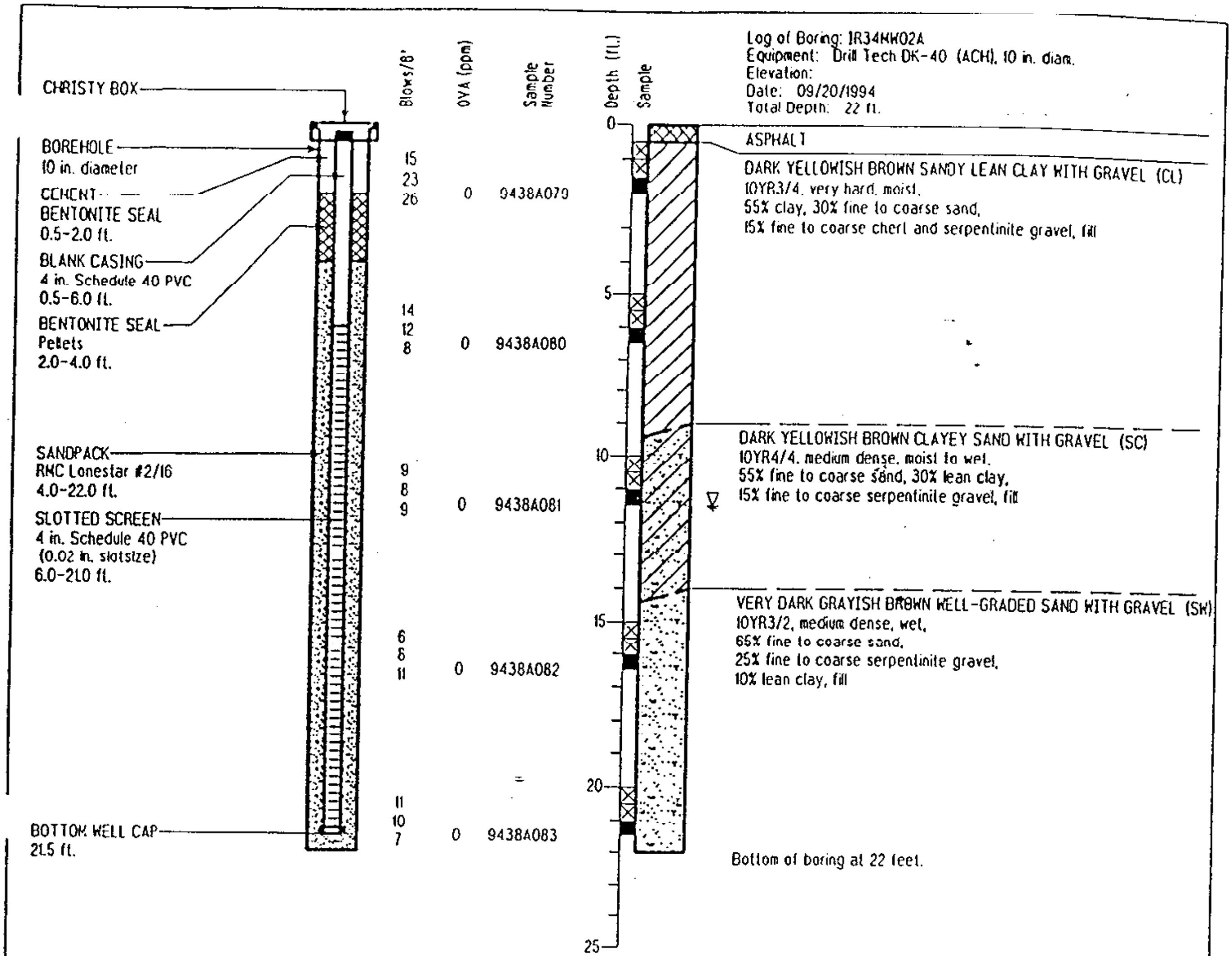
Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR34MW01A

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1418		12/94	



Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR34MW02A

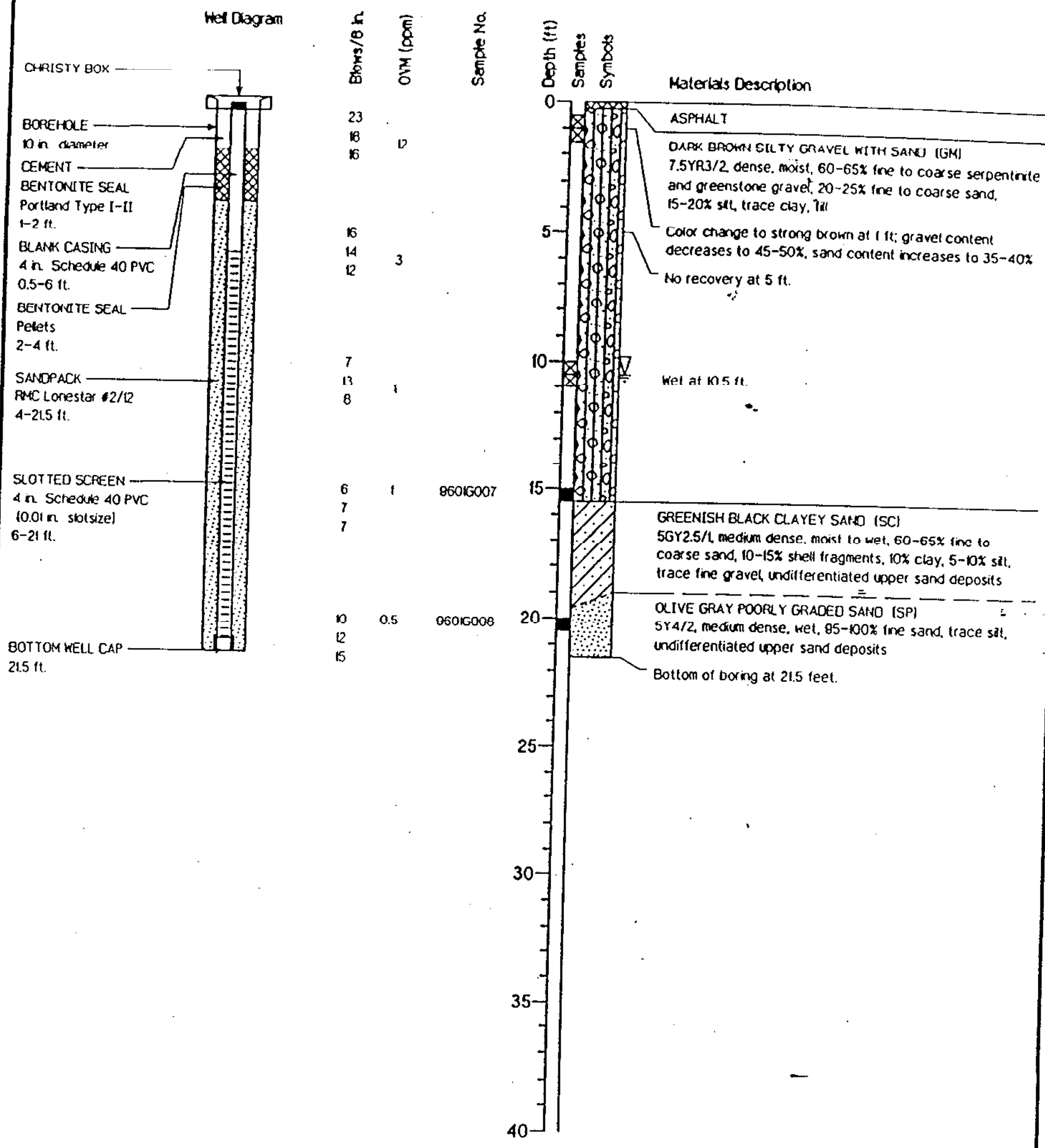
PLATE

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1418		12/94	

PRC Environmental Management, Inc.

LOG OF BORING IR34MW35A

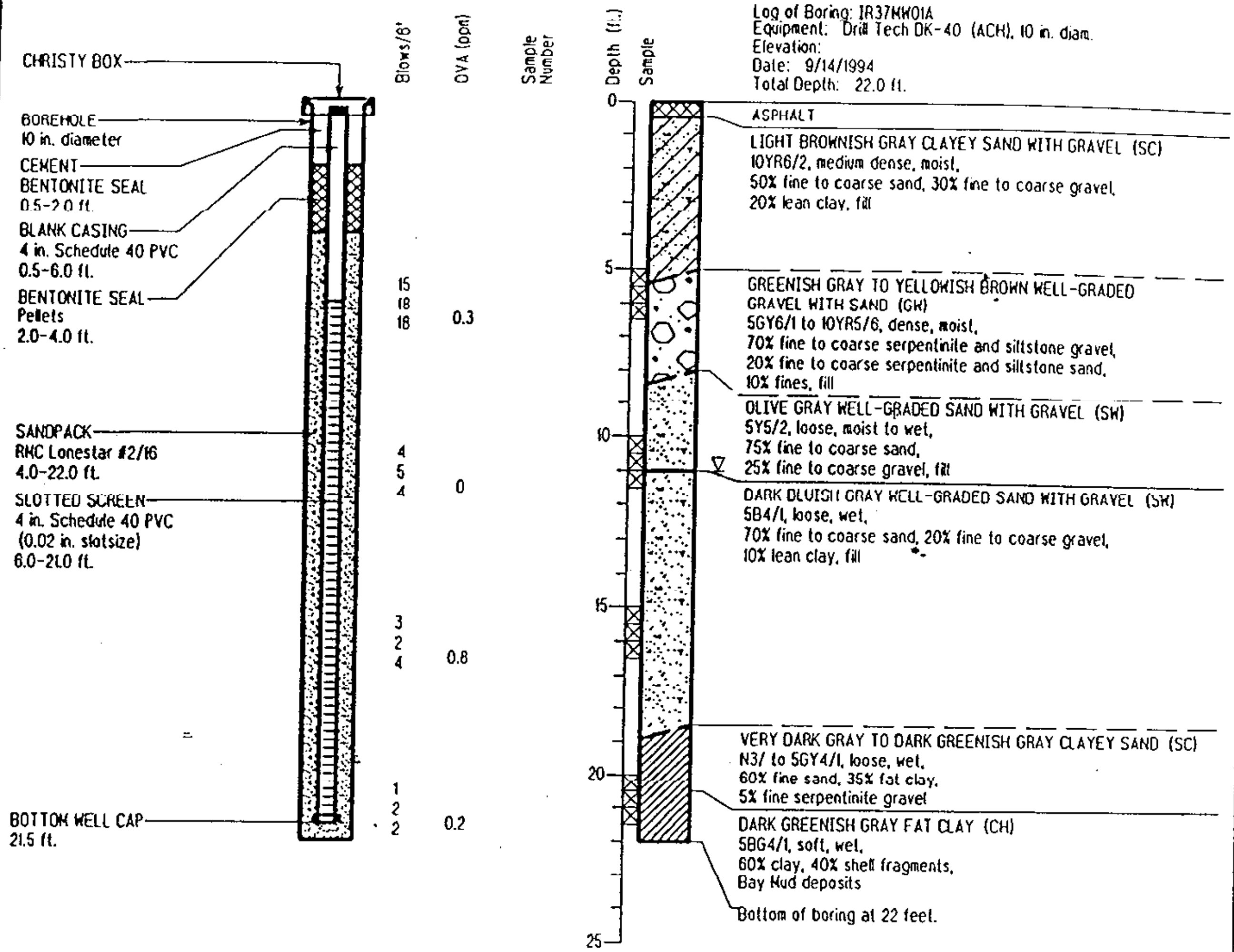


Project Number CTO 5
Project Name Parcel D RI Report
Project Task Hunters Point Annex
Project Location San Francisco, California
Equipment Air Casing Hammer (ACH) 10 in. diam.

Date Drilled 1/2/96
GS Elevation 9.02 ft.
First Encountered Wet Soil 10.5 ft.
Total Depth Of Borehole 21.5 ft.

Figure

Log of Boring: IR37MW01A
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation:
Date: 9/14/1994
Total Depth: 22.0 ft.



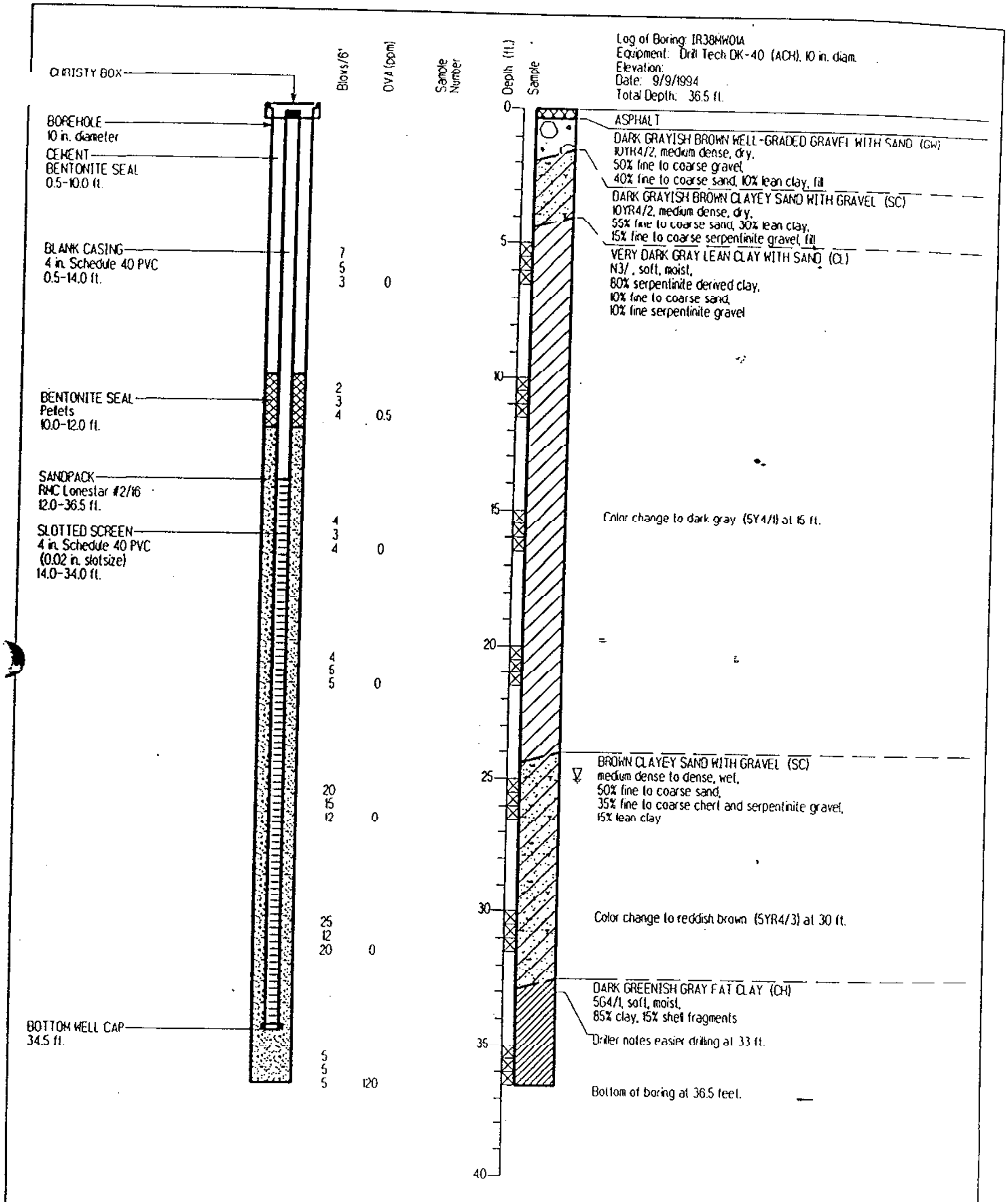
Harding Lawson Associates
Engineering and
Environmental Services

Log of Boring and Well Completion IR37MW01A

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1418		12/94	



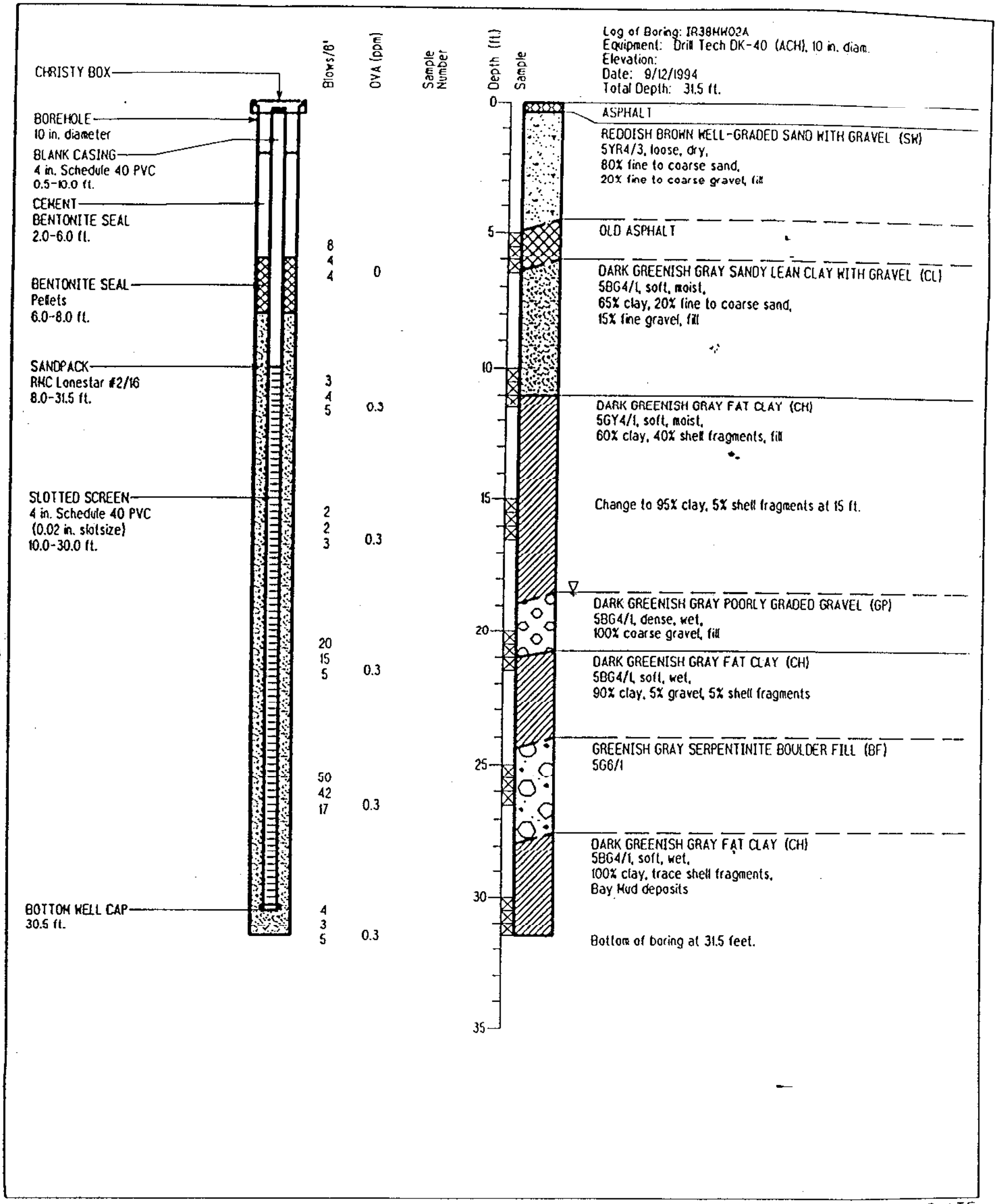
Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion IR38MW01A

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1418		12/94	



Harding Lawson Associates
Engineering and
Environmental Services

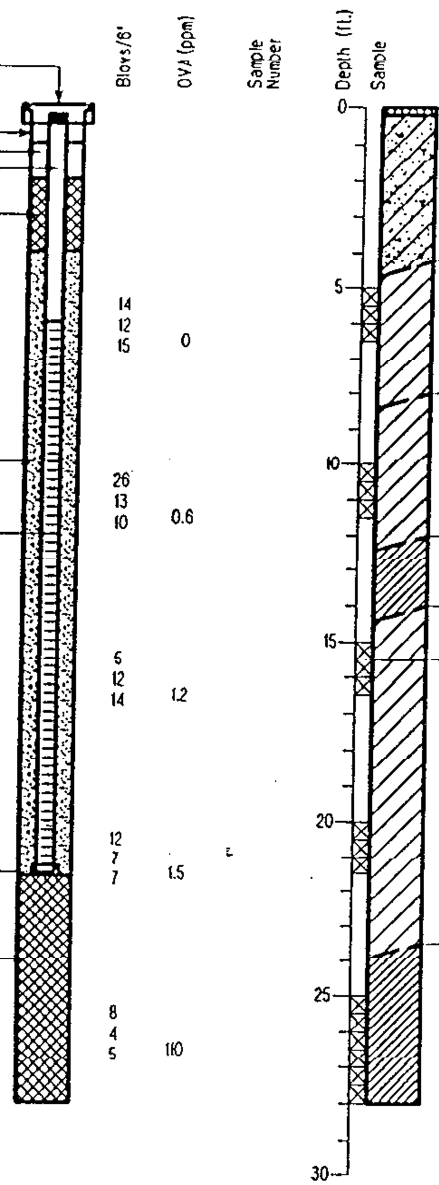
Log of Boring and Well Completion IR38MW02A

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1418		12/94	

Log of Boring: IR38MW03A
Equipment: Drill Tech OK-40 (ACH), 10 in. diam.
Elevation:
Date: 09/07/1994
Total Depth: 28 ft.



CHRISTY BOX

BOREHOLE
10 in. diameter

CEMENT

BENTONITE SEAL
1.0-2.0 ft.

BLANK CASING
4 in. Schedule 40 PVC
0.5-6.0 ft.

BENTONITE SEAL
Pellets
2.0-4.0 ft.

SANDPACK
RMC Lonestar #2/16
4.0-21.5 ft.

SLOTTED SCREEN
4 in. Schedule 40 PVC
(0.02 in. slotsize)
6.0-21.0 ft.

BOTTOM WELL CAP
21.5 ft.

BENTONITE
CHIP SEAL
21.5-28.0 ft.

Blows/6"	OVA (ppm)
14, 12, 15	0
26, 13, 10	0.6
6, 12, 14	1.2
12, 7, 7	1.5
8, 4, 5	110

ASPHALT

VERY DARK GRAY CLAYEY SAND WITH GRAVEL (SC)
5Y3/1, medium dense, dry,
50% fine to coarse sand, 30% lean clay,
20% fine to coarse serpentinite and greenstone gravel, fill

VERY DARK GRAY LEAN CLAY WITH SAND (CL)
5Y3/1, hard, moist,
80% clay, 10% fine to coarse sand,
10% fine to coarse serpentinite gravel, fill

VERY DARK GRAY LEAN CLAY (CL)
5Y3/1, hard, moist,
90% clay, 10% fine to coarse sand, fill

VERY DARK GRAY SANDY FAT CLAY WITH GRAVEL (CH)
5Y3/1, firm, wet,
55% clay, 30% fine to coarse sand,
15% fine to coarse serpentinite gravel, fill

DARK BLUISH GRAY LEAN CLAY WITH GRAVEL (CL)
5B4/1, hard, moist,
80% serpentinite derived clay,
20% fine to coarse gravel, fill

DARK GREENISH GRAY GRAVELLY LEAN CLAY (CL)
5GY4/1, medium dense, wet,
70% clay, 30% fine to coarse gravel, fill

DARK GREENISH GRAY FAT CLAY (CH)
5G4/1, soft, moist,
85% clay, 15% shell fragments,
Bay Mud deposits

Bottom of boring at 28 feet.

Harding Lawson Associates
Engineering and
Environmental Services

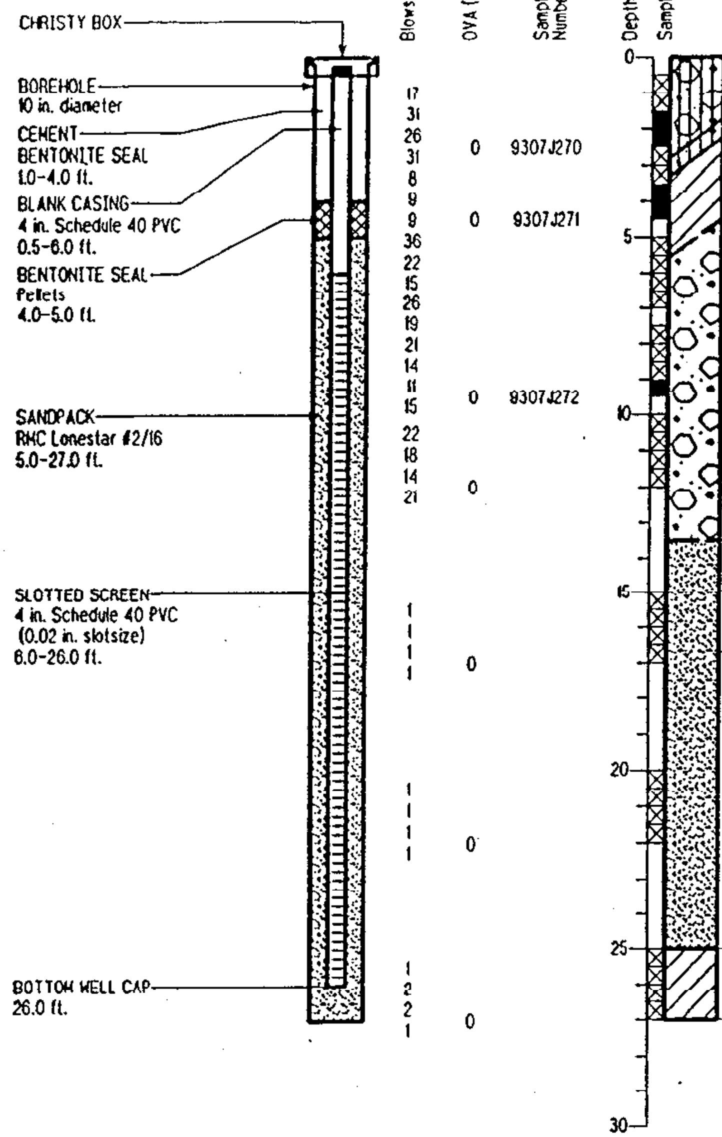
Log of Boring and Well Completion IR38MW03A

Engineering Field Activity West
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1418		12/94	

Log of Boring: PA39MW01A
Equipment: Drill Systems 1000 (ACH), 10 in. diam.
Elevation: GS 5.08 ft.
Date: 02/16/1993
Total Depth: 27 ft.



DARK GRAY SILTY GRAVEL (GM)
5Y4/1, loose, dry,
70% fine angular gravel, 20% silt,
10% sand, fill

Red chert boulder/cobble at 1.5 ft.

VERY DARK GRAYISH BROWN WELL-GRADED GRAVEL WITH SAND (GW)
10YR3/2, loose, moist,
60% gravel, 30% sand, 10% silt, fill

BLACK GRAVELLY LEAN CLAY (CL)
5Y2.5/2, medium stiff, moist,
65% clay, 35% serpentinite chert
and sandstone gravel, fill

DARK GRAY COBBLE AND BOULDER FILL
5Y4/1, loose, wet,
approximately 10% fine-grained sand,
10% silt, fill

No recovery from 5 to 7 ft.

BLACK POORLY GRADED SAND (SP)
N2/, loose, wet,
fine-grained sand, 5% sand-sized shell
material, Undifferentiated Upper Sands

Layer of shell fragments 0.1 ft. thick at 16.6 ft.

Dark olive gray clay lens (CL) (5Y3/2) containing organic fibers from 16.7 to 17.3 ft.

Color change to dark gray (5Y4/1), trace shell fragments at 20 ft.

DARK GREENISH GRAY LEAN CLAY (CL)
5GY4/1, medium stiff, wet,
50% clay, 50% broken shell fragments, Bay Mud deposits

Bottom of boring at 27 feet.

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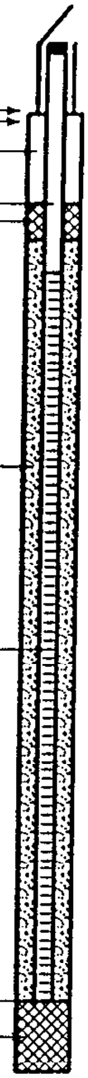
Log of Boring and Well Completion PA39MW01A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

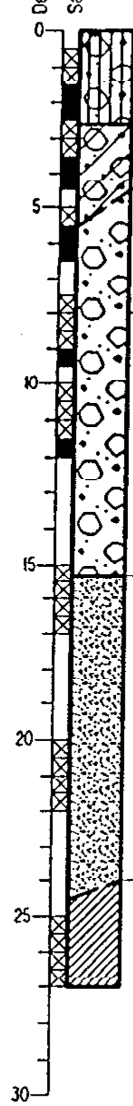
PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 090403		11/93	

Log of Boring: PA39MW02A
Equipment: Drill Systems 1000 (ACH), 10 in. diam.
Elevation: GS 5.40 ft.
Date: 02/17/1993
Total Depth: 27 ft.



Blows/6"	OVA (ppm)	Sample Number
4, 4, 5, 7	0	9307J273
5, 5, 8, 35	0	9307J274
28, 22, 14	0	9307J275
11, 10, 10, 7	0	9307J276
11, 8, 11, 8	0	9307J277
29, 9, 6, 9	0	
6, 4, 4, 3	0	
4, 3, 3, 3	0	



VERY DARK GRAYISH BROWN SILTY GRAVEL WITH SAND (GM)
2.5Y3/2, loose, wet,
60% fine angular gravel (mostly black shale),
20% silt, 20% fine-grained sand, grass and
roots at surface, fill

BLACK CLAYEY GRAVEL (GC)
5Y2.5/2, medium dense, moist to wet,
70% sandstone gravel (some cobbles), 20% clay,
10% redwood fragments, fill

DARK GREENISH GRAY BOULDER FILL
5G4/1, mostly metamorphic rock

Wet, dark gray (5Y4/1) at 8 ft.

VERY DARK GRAY POORLY GRADED SAND (SP)
5Y3/1, loose, wet,
90% sand, 5% clay, 5% shell fragments,
Undifferentiated Upper Sand deposits

FAT CLAY (CH)
50% clay, 50% shell fragments, Bay Mud deposits

Bottom of boring at 27 feet.
Boring backfilled with bentonite chips to 25 feet.

Harding Lawson Associates
Engineering and
Environmental Services

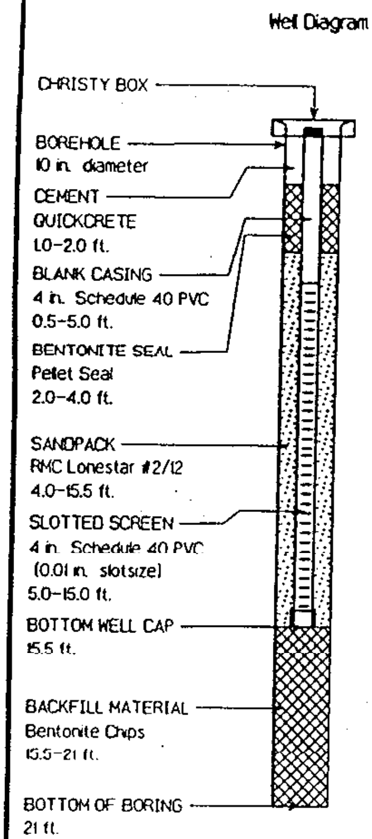
Log of Boring and Well Completion PA39MW02A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 090403		11/93	

PRC Environmental Management, Inc.

LOG OF BORING IR44MW08A



Blows/6 in.	OVM (ppm)	Sample No.	Depth (ft)
50/3"	3.7	9538J256	0
27 30 36			5
7 10 10	0	9538J257	10
5 10 11	0.1	9538J259	15
4 6 12	0.1	9538J260	20

Materials Description

ASPHALT

BROWN GRAVELLY SILT WITH SAND (ML)
10YR4/3, hard, slightly moist, 50% silt and clay, 30% fine gravel, 20% fine sand, fill

No recovery at 5 ft.

BROWN CLAYEY GRAVEL WITH SAND (GC)
10YR4/3, medium dense, wet, 45% fine gravel, 30% fine to coarse sand, 25% clay, fill

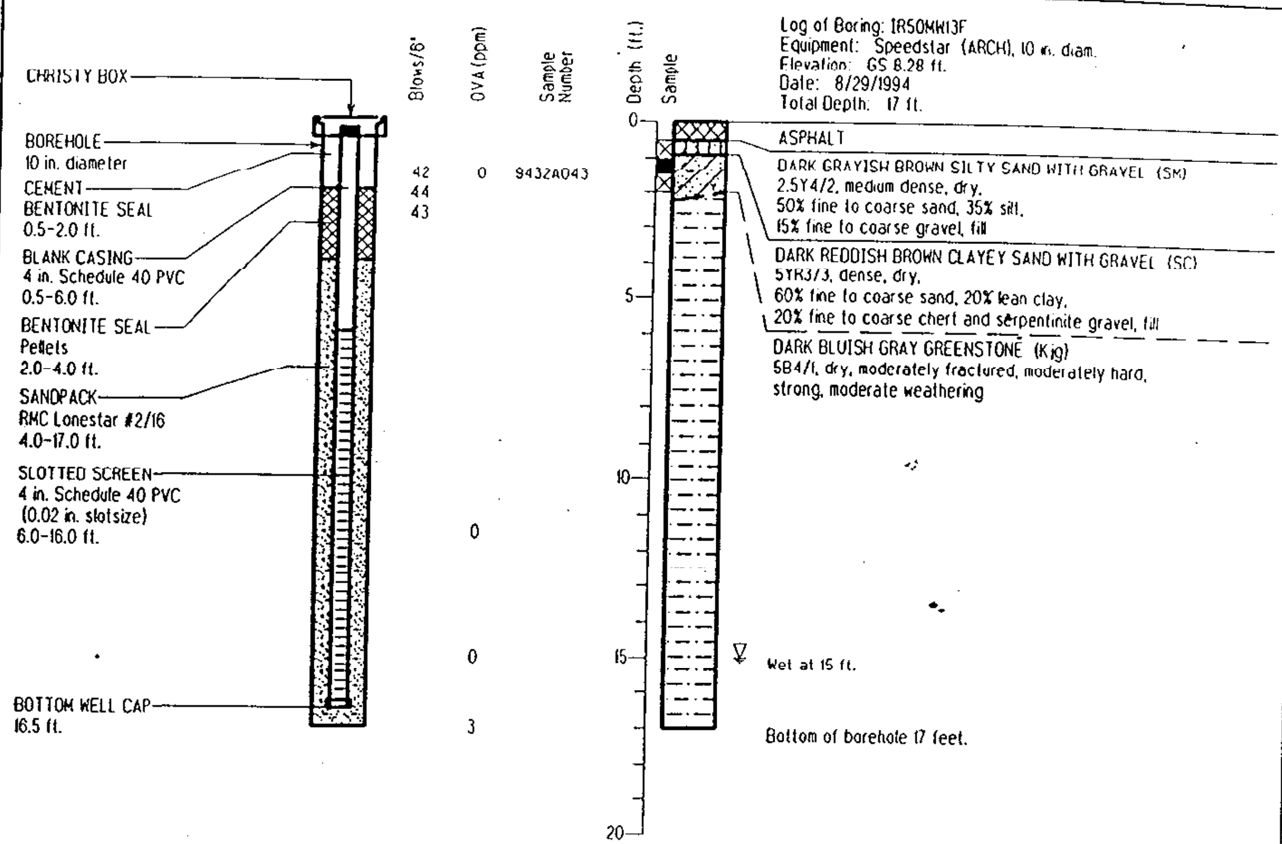
BLACK FAT CLAY (CH)
N2.5/ , firm, wet, 65% clay, 35% shells and shell fragments, bay mud deposits

Hydropunch groundwater sample 9538J258 collected from borehole; screened from 12.5 to 15 ft.

Bottom of boring at 21.0 feet. Boring backfilled with bentonite chips to 15.5 feet.

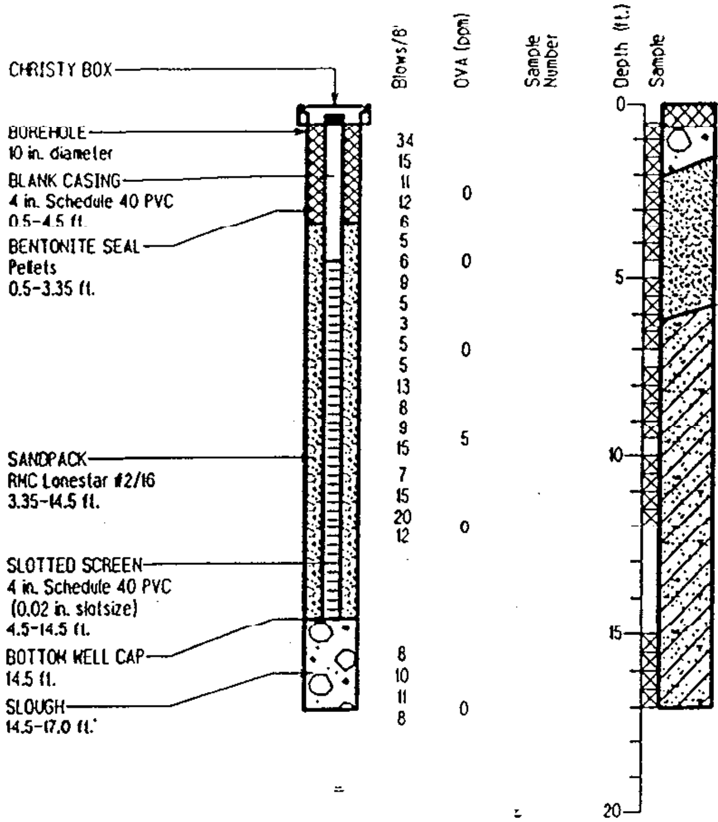
Project Number CTO 5	Date Drilled 09/18/95
Project Name Parcel D RI Report	GS Elevation 7.65 ft.
Project Task Hunters Point Annex	First Encountered Wet Soil 10 ft.
Project Location San Francisco, California	Total Depth Of Borehole 21 ft.
Equipment Hollow Stem Auger (HSA) 10 in. diam.	

Figure



Harding Lawson Associates Engineering and Environmental Services		Log of Boring and Well Completion IR50MW13F Naval Station Treasure Island Hunters Point Annex San Francisco, California		PLATE
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1410		05/95	

Log of Boring: PA50MW03A
Equipment: Drill Systems 1000 (ACH), 10 in. diam.
Elevation: GS 7.37 ft.
Date: 03/08/1993
Total Depth: 17 ft.



ASPHALT

DARK GRAY WELL-GRADED GRAVEL (GW)
2.5Y4/1, loose, dry,
85% fine to coarse angular gravel, 10% medium- to coarse-grained sand, 5% silt, fill

OLIVE BROWN POORLY GRADED SAND (SP)
loose, dry,
85% sand, 10% clay, 5% gravel, fill

Color change to olive brown (2.5Y4/4) at 3.5 ft.

DARK BROWN CLAYEY SAND WITH GRAVEL (SC)
7.5YR3/3, loose, wet,
65% medium-grained sand, 20% gravel, 15% clay, fill

Coarse gravel-size pieces of asphalt from 9 to 10 ft.

Some serpentinite gravel at 15 ft.

Bottom of boring at 17 feet. Boring caved to 14.5 feet when augers were pulled up.

PLATE

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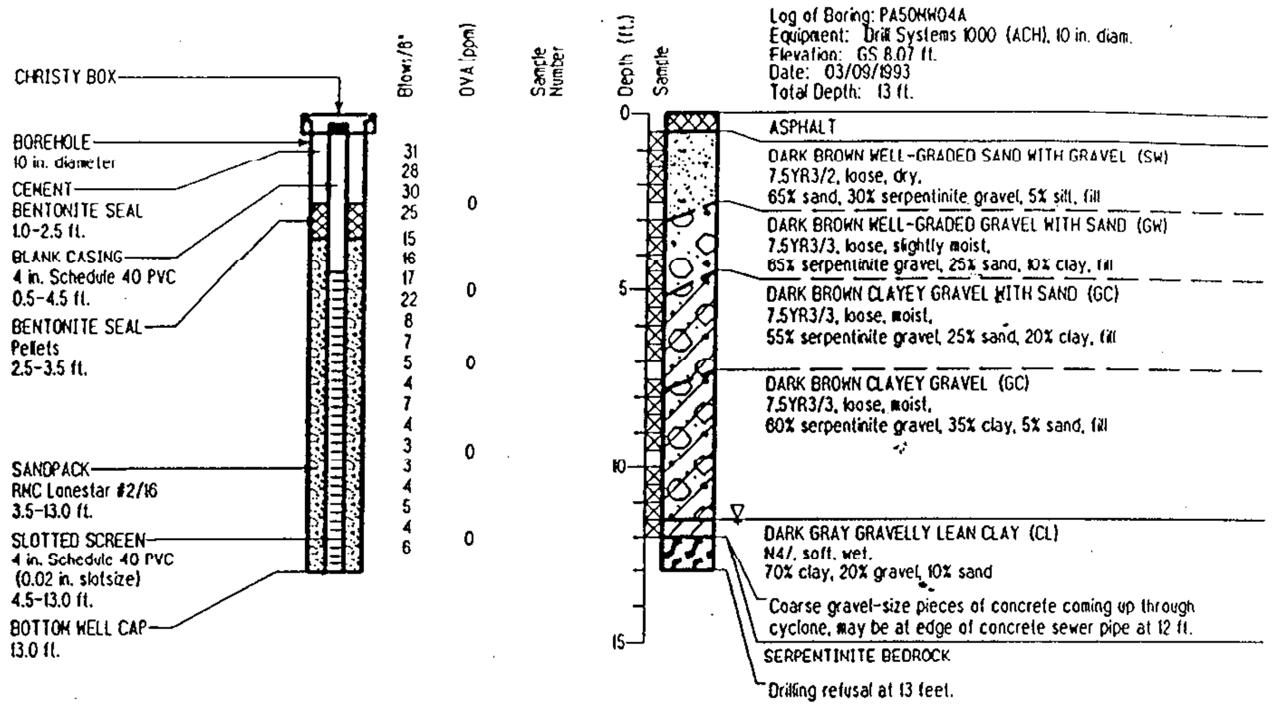
Log of Boring and Well Completion PA50MW03A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 090401		11/93	

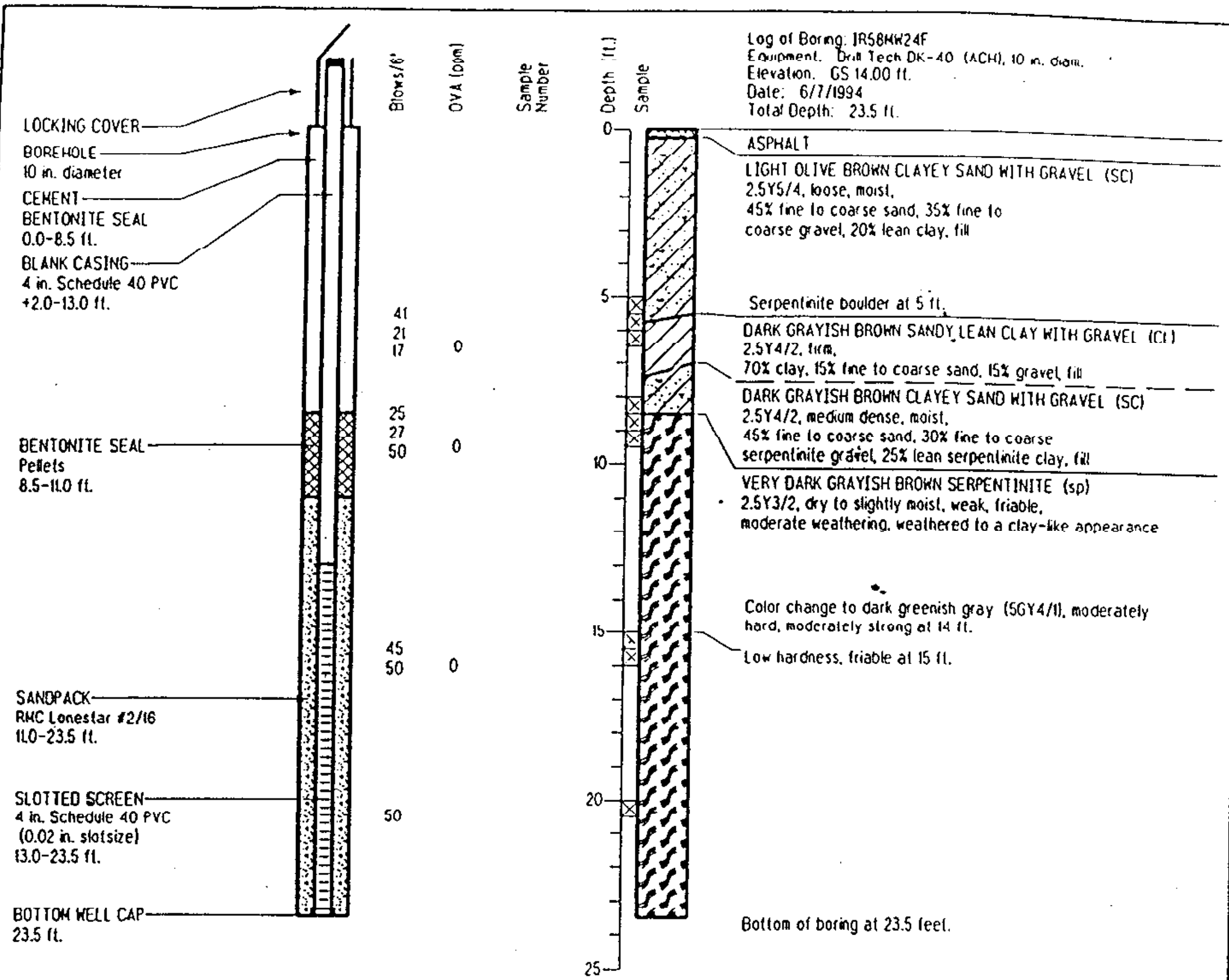


Harding Lawson Associates
Engineering and Environmental Services

Log of Boring and Well Completion PA50MW04A
Naval Station, Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 090401		11/93	



Harding Lawson Associates
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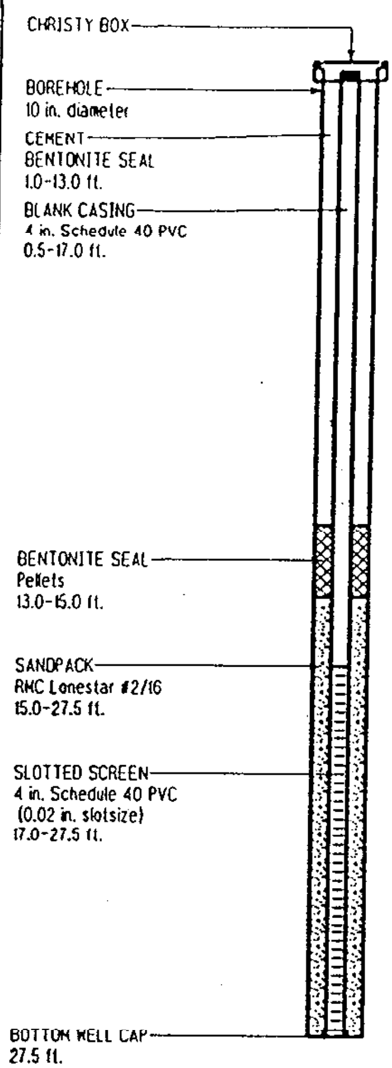
Environmental Services

Log of Boring and Well Completion IR58MW24F
Parcel C Site Inspection Report
Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

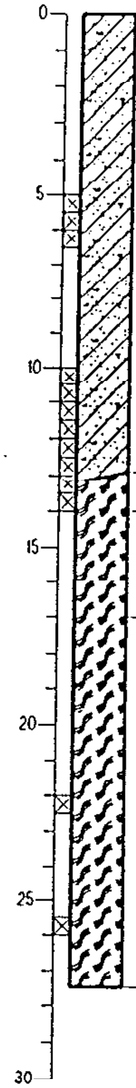
PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LRH	11400 1410		08/94	

Log of Boring: IR58MW25F
Equipment: Drill Tech DK-40 (ACH), 10 in. diam.
Elevation: GS 10.49 ft.
Date: 06/06/1994
Total Depth: 27.5 ft.



Blows/6"	OVA (ppm)	Sample Number	Depth (ft.)
7, 8, 7	0		5–6.5
6, 8, 8, 6, 8, 9, 18, 50			10–13.5
50			~17
50			~22
50			~25



DARK YELLOWISH BROWN CLAYEY SAND (SC)
10YR4/4, medium dense, moist,
80% fine to medium sand, 20% fat clay, fill

Decreasing sand to 60% at 10 ft., increasing fat clay to 40%, few small gravel-sized oxidation nodules, trace chert gravel

OLIVE BROWN SERPENTINITE (sp)
2.5Y4/3, moist, low hardness, weak, moderate weathering to a lean clay-like material

Color change to dark greenish gray at 14 ft., moderately hard, strong

Color change to dark olive gray (5Y3/2) at 17 ft., dry, intensely fractured with calcite filling

Color change to dark yellowish brown (10YR4/2) at 20 ft., moist, low hardness, friable

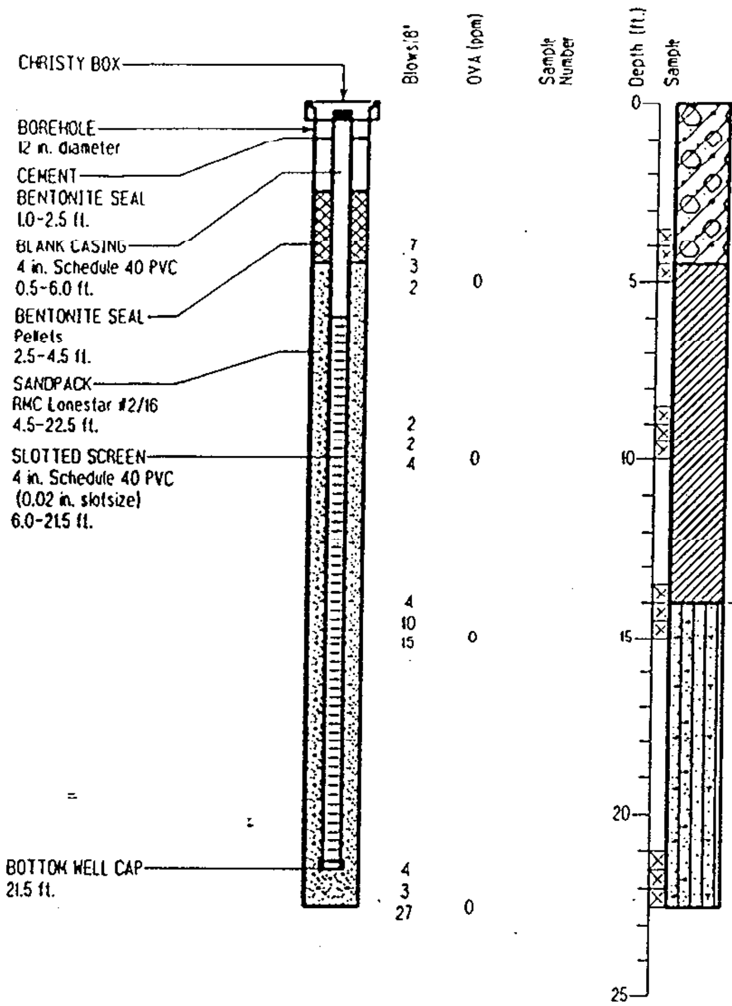
Color change to dark grayish brown (2.5Y4/2) at 22 ft., dry to slightly moist, weak to friable, weathering to a lean clay-like material

Color change to dark olive gray (5Y3/2) at 25 ft., friable

Bottom of boring at 27.5 feet.

Harding Lawson Associates Engineering and Environmental Services	Log of Boring and Well Completion IR58MW25F Naval Station Treasure Island Hunters Point Annex San Francisco, California		PLATE
DRAWN: klr	JOB NUMBER: 11400 1410	APPROVED	DATE: 08/94 — REVISED DATE

Log of Boring: IR58MW26A
Equipment: CME 85 (HSA), 12 in. diam.
Elevation: GS 8.83 ft.
Date: 05/26/1994
Total Depth: 22.5 ft.



VERY DARK BROWN CLAYEY GRAVEL (GC)
10YR2/2, loose, moist,
60% fine to coarse gravel, 40% clay, fill

BLACK SANDY FAT CLAY (CH)
N2.5/, soft, moist,
65% clay, 35% fine to very fine sand, fill

Color change to dark olive gray (5Y3/2) at 9.5 ft.

BROWN SILTY SAND (SM)
10YR4/3, medium dense, moist,
50% fine sand, 45% silt,
5% coarse sand to fine gravel,
Undifferentiated Sedimentary deposits

Bottom of borehole 22.5 feet.

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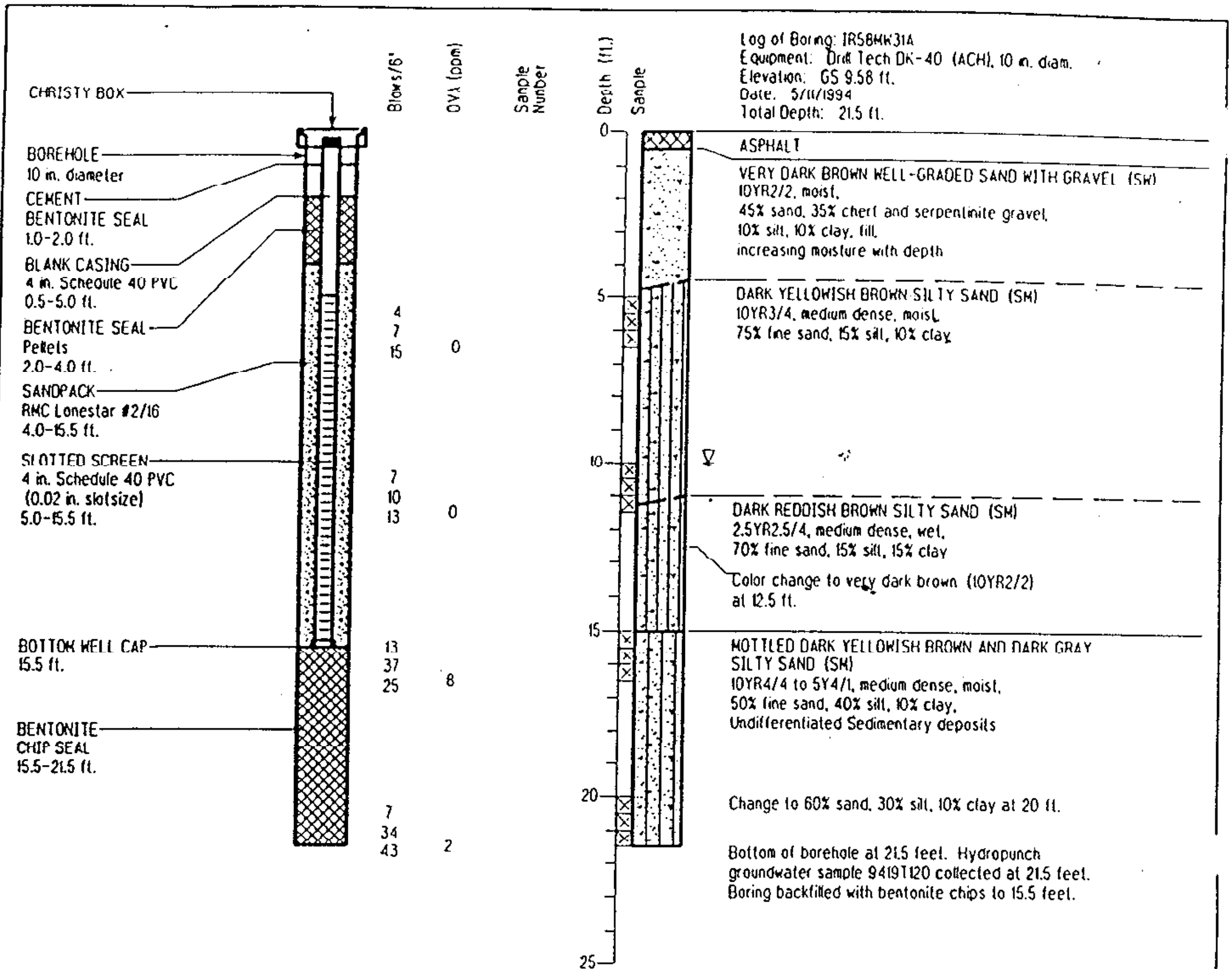
Engineering and Environmental Services

Log of Boring and Well Completion IR58MW26A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
klr	11400 1410		06/94	



Harding Lawson Associates
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Environmental Services

Log of Boring and Well Completion IR58MW31A

Naval Station Treasure Island
Hunters Point Annex
San Francisco, California

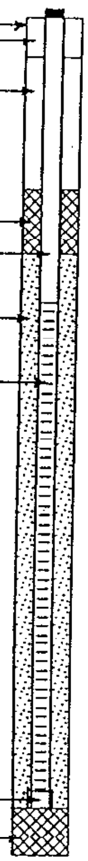
PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
ktr	11400 1410		08/94	

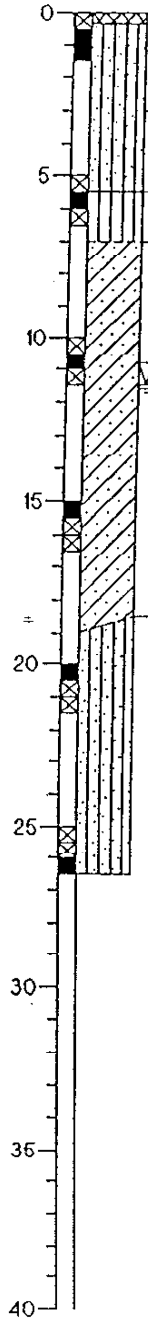
PRC Environmental Management, Inc.

LOG OF BORING IR58MW32B

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.	Depth (ft)
5, 6, 5	0	9613J978	0
3, 2, 2	6.1	9613J979	5
3, 1, 3	1.6	9613J980	10
		9613J981	15
2, 1	0	9613J982	20
5, 6, 3		9613J983	25



Materials Description

ASPHALT

DARK REDDISH BROWN SILTY SAND (SM)
5YR3/3, medium dense, moist, 75% fine sand, 15% silt, 10% medium coarse chert gravel, fill

Color change to black (5Y2.5/1) by 3 ft., loose, very moist, 60% fine sand, 25% silt, 10% fine serpentinite gravel, 5% lean clay

LIGHT OLIVE BROWN SILT WITH SAND (ML)
2.5Y5/6, soft, moist, 80% silt, 15% fine sand, 5% lean clay, fill

MOTTLED DARK YELLOWISH BROWN AND DARK GREENISH GRAY CLAYEY SAND (SC)
10YR4/4 to 5Y4/1, medium dense, moist, 60% fine sand, 30% lean clay, 10% silt, undifferentiated sedimentary deposits

LIGHT OLIVE BROWN SILTY SAND (SM)
2.5Y5/6, loose, very moist, 85% fine sand, 15% silt, trace dark brown nodes 1–2 mm in diameter, undifferentiated sedimentary deposits

Bottom of boring at 26.5 feet. Boring backfilled with bentonite pellets to 25 feet.

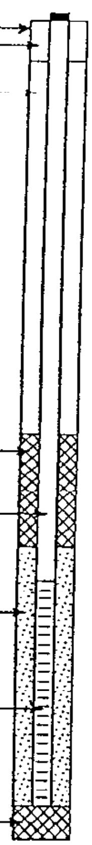
Project Number	CTO 0H	Date Drilled	03/28/96
Project Name	Parcel C RI Report	GS Elevation	9.14 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	11.5 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	26.5 ft.
Equipment	Air Rotary Casing Hammer, 12 in. diam.		

Figure

PRC Environmental Management, Inc.

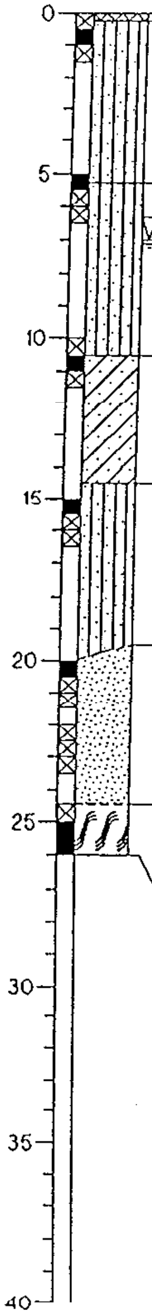
LOG OF BORING IR58MW33B

Well Diagram



- CHRISTY BOX
- BOREHOLE 12 in. diameter
- CONCRETE 0.0–2.0 ft.
- BENTONITE CEMENT GROUT 2.0–13.5 ft.
- BENTONITE PELLET SEAL 13.5–17.0 ft.
- BLANK CASING 4 in. Schedule 40 PVC 0.75–18.0 ft.
- SANDPACK RMC Lonestar #2/12 17.0–25.0 ft.
- SLOTTED SCREEN 4 in. Schedule 40 PVC (0.010 in. slotsize) 18.0–25.0 ft.
- BENTONITE CHIP SEAL 25.0–26.0 ft.

Blows/6 in.	OVM (ppm)	Sample No.
6, 3, 5	0	9614J018
8, 6, 5	0	9614J019
3, 4, 3	335	9614J020
6, 5, 8	15	9614J021
6, 8, 18	0	9614J022
8, 15, 13	0	
15, 13, 12	0	9614J023



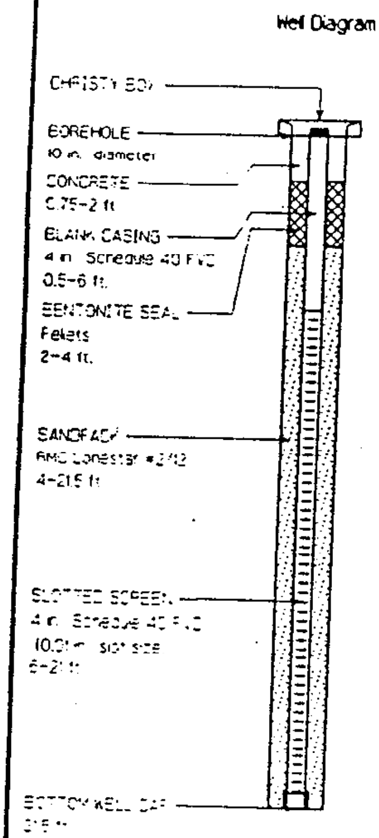
Depth (ft)	Materials Description
0	ASPHALT
	VERY DARK BROWN SILTY SAND WITH GRAVEL (SM) 7.5YR2.5/3, medium dense, moist, 65% fine to medium sand, 20% silt, 15% fine to medium chert gravel, fill
5	DARK YELLOWISH BROWN SILTY SAND (SM) 10YR3/4, medium dense, moist, 75% fine sand, 15% silt, 10% lean clay, undifferentiated sedimentary deposits
10	DARK GREENISH GRAY CLAYEY SAND (SC) 10BG4/1, loose, wet, 85% fine sand, 15% lean clay, heavy solvent odor, undifferentiated sedimentary deposits
15	DARK YELLOWISH BROWN SILTY SAND (SM) 10YR3/4, medium dense, moist, 85% fine sand, 15% silt, undifferentiated sedimentary deposits
20	DARK YELLOWISH BROWN POORLY GRADED SAND (SP) 10YR3/4, dense, moist, 95% fine sand, 5% silt, undifferentiated sedimentary deposits
25	OLIVE SERPENTINITE BEDROCK (sp) 5Y4/4, hard, moist, moderately to closely fractured, deeply weathered
	Bottom of boring at 26 feet. Boring backfilled with bentonite chips to 25 feet.

Project Number	C10 011	Date Drilled	04/03/96
Project Name	Parcel C RI Report	GS Elevation	8.36 ft.
Project Task	Hunters Point Shipyard	First Encountered Wet Soil	7 ft.
Project Location	San Francisco, California	Total Depth Of Borehole	26 ft.
Equipment	Air Rotary Casing Hammer, 12 in. diam.	Figure	

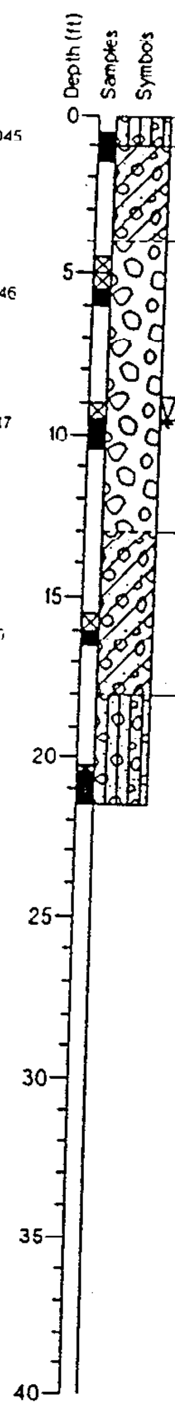
PRC Environmental Management, Inc.

LOG OF BORING IR71MW03A

Well Diagram



Blows/6 in.	OVM (ppm)	Sample No.
36 50	2	9533G045
42 46 28	2	9533G046
12 12 10	4	9533G047
12 13 14	3.7	9533G050
25 35 46	5	9533G051



Materials Description

DARK YELLOWISH BROWN SILTY GRAVEL WITH SAND (GM) 10YR4/4, medium dense, dry, 55–60% fine to coarse gravel, 25–30% fine to coarse sand, 15–20% silt, fill

DARK RED CLAYEY GRAVEL WITH SAND (GC) 2.5YR4/6, medium dense, moist, 60–65% fine to coarse gravel, 20–25% clay, 15% coarse sand, 5–10% silt, fill

YELLOWISH BROWN WELL-GRADED GRAVEL WITH SAND (GW) 10YR5/6, dense, moist, 70–75% fine to coarse gravel, 15–20% medium to coarse sand, 5–10% silt and clay, fill

Color change to light olive brown (2.5Y5/6) at 9.5 ft; sample is wet.

Hydropunch® groundwater sample 9533G048 collected from boring; screened from 11.5 to 14.5 ft.

STRONG BROWN CLAYEY GRAVEL WITH SAND (GC) 7.5YR4/6, medium dense, wet, 60–65% fine to coarse gravel (some serpentinite), 15–20% medium to coarse sand, 15% clay, 5–10% silt, fill

STRONG BROWN SILTY GRAVEL WITH SAND (GM) 7.5YR4/6, dense, wet, 60–65% fine to coarse serpentinite gravel, 15–20% fine to coarse sand, 15% silt, 5% clay, fill

Bottom of boring at 21.5 feet

Project Number 073 5	Date Drilled 3/17/95	Figure	
Project Name Parcel D RI Report	GS Elevation 8.65 ft.		
Project Task Hunters Point Annex	First Encountered Wet Soil 9.5 ft.		
Project Location San Francisco, California	Total Depth Of Borehole 21.5 ft.		
Equipment Hollow Stem Auger (HSA) 10 in. diam.			

APPENDIX E

STANDARD OPERATING PROCEDURES – International Technology Corporation

SAMPLING EQUIPMENT AND WELL MATERIAL DECONTAMINATION

STANDARD OPERATING PROCEDURE

1.0 Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the decontamination of sampling equipment and well construction materials. Proper equipment decontamination is essential in ensuring the quality and integrity of samples collected during a given sampling event. Additional specific sampling equipment and well material decontamination procedures and requirements will be provided in the project work plans.

2.0 References

2.1 EPA, September 1987, EPA Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01.

2.3 SOP 6.2 - Drilling and Heavy Equipment Decontamination

2.4 SQP 4.2 - Records Management

3.0 Definitions

3.1 Deionized Analyte-Free Water

Ion-free, analyte-free water produced on site or purchased from a supplier with a deionization chamber equipped with a carbon filter.

3.2 Potable Water

Treated municipal water.

3.3 Laboratory Grade Detergent

A standard brand of laboratory-grade detergent, such as "Alconox" or "Liquinox."

3.4 Methanol

Laboratory-grade methanol alcohol, CAS #67-56-1.

3.5 Hexane

Laboratory-grade hexane, CAS #110-54-3.

3.6 HPLC Water

High purity laboratory-grade water.

4.0 Procedure

This section contains responsibilities, requirements, and procedures for sampling equipment and well material decontamination. The decontamination is required to maintain proper quality and integrity of collected samples.

The details within this SOP should be used in conjunction with the project work plans. The project work plans will provide the following information:

- Types of equipment requiring decontamination under this SOP;
- Specific materials to be used for the decontamination; and
- Additional decontamination requirements and procedures beyond those covered in this SOP, as necessary.

All field personnel associated with decontamination of sampling equipment or well materials must read both this SOP and the project work plans prior to implementation of related decontamination activities. Information and requirements for the decontamination of any and all drilling and heavy equipment is provided in SOP No. 6.2.

4.1 Responsibilities

4.1.1 The Delivery Order Manager is responsible for ensuring that all sampling equipment and well material decontamination activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

4.1.2 The Contractor Quality Control Manager (CQCM) is responsible for periodic review of field generated documentation associated with this SOP. The CQCM is also responsible for the implementation of corrective action (i.e., retaining personnel, additional review of work plans and SOPs, variances to decontamination requirements, issuing nonconformances, etc.) if problems occur.

4.1.3 Field personnel assigned to sampling equipment and well material decontamination activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the Site Superintendent, Delivery Order Manager, or the CQCM.

4.2 Decontamination Facility

If possible, sampling equipment decontamination will take place in an area designed exclusively for decontamination. This area will ideally be located within the contamination reduction zone on the project site. Well materials may be decontaminated at the facility set up for decontamination of drilling and heavy equipment (see SOP No. 6.2).

Each decontamination facility will be constructed so that the equipment, as well as all wastes generated during decontamination (e.g.: soil, rinsate, liquid spray, debris, etc.), are fully contained. In addition, chemical products used in the decontamination process must be properly containerized and labelled.

4.3 Decontamination of Nondedicated Sampling Equipment

Each piece of reusable, nondedicated sampling equipment will be decontaminated before mobilization to each site and before each sampling event. The standard procedure will be performed as described below.

4.3.1 Suitable personal protective equipment (specified by the project work plans) must be worn by all personnel involved with the task to reduce personal exposure.

4.3.2 Heavily caked soil and/or other material will be scraped or brushed from equipment. The scrapings will be placed into an appropriate container for disposal. Steam cleaning of equipment may be required to remove material from samplers.

4.3.3 Equipment that will not be damaged by water should be placed into a wash tub containing a laboratory-grade detergent solution and scrubbed with a brush or clean cloth. Rinsing will then be conducted with fresh, potable water, followed by deionized water.

4.3.4 Methanol, hexane, and HPLC water rinses may then follow for some sampler components when specified by the project work plans.

4.3.5 Any equipment that may be damaged by submersion into water will be wiped clean using a sponge and detergent solution. Cleaning will be followed by wiping the equipment with deionized water.

4.3.6 Air dry the rinsed equipment. Soil organic vapor (SOV) sampling equipment should be flushed dry with bottled air of known quality and/or as per the project work plans.

4.3.7 Place decontaminated equipment on clean plastic sheeting to prevent contact with contaminated soil. If equipment is not used immediately, cover or wrap the equipment in clean plastic sheeting to minimize airborne contamination.

4.3.8 Decontamination activities shall be documented on the Field Activity Daily Log (FADL) (Attachment 6.1) or other appropriate form(s), as specified by the project work plans.

4.4 Decontamination of Dedicated Sampling Equipment

Dedicated sampling equipment, such as submersible pumps, will be decontaminated prior to installation inside monitoring wells. At a minimum, the procedure outlined below must be performed. If factory-cleaned, hermetically sealed materials are used, no decontamination will be necessary, provided that laboratory certification of decontamination is submitted with the equipment.

4.4.1 Suitable personal protective equipment will be worn by all personnel involved in the task, in accordance with the project work plans.

4.4.2 Foot vale and pumping lines will be washed with a laboratory-grade detergent solution.

4.4.3 The equipment will then be rinsed twice with tap water, followed by a rinse with deionized water.

4.4.4 Air dry.

4.4.5 Place decontaminated equipment on clean plastic sheeting to prevent contact with contaminated soil. If equipment is not used immediately, cover or wrap the equipment in clean plastic sheeting to minimize airborne contamination.

4.4.6 Decontamination activities will be documented on the FADL or the appropriate form(s), as specified by the project work plans.

4.5 Decontamination of Well Materials

Well materials including well casing, well screens, centralizers, and end caps will be decontaminated prior to use in constructing monitoring wells. (If factory-cleaned, hermetically sealed material are used, no decontamination will be necessary provided that laboratory decontamination certification is submitted with the equipment.) The standard procedure outlined below must be performed when decontaminating well materials.

4.5.1 Appropriate personal protective equipment will be worn by all personnel involved in the task, in accordance with the project work plans.

4.5.2 Materials will be thoroughly sprayed and washed with water using a high pressure steam cleaner.

4.5.3 Air dry.

4.5.4 Decontaminated materials will be placed on clean metal racks or clean plastic sheeting. If equipment is not used immediately, cover or wrap the equipment in clean plastic sheeting to minimize airborne contamination.

4.5.5 Decontamination activities will be documented on the FADL or other appropriate form(s), as specified by the project work plans.

5.0 Records

Records generated as a result of this SOP will be maintained in the Project Records file in accordance with SQP No. 4.2.

6.0 Attachments

6.1 Field Activity Daily Log

DRILLING, DEVELOPMENT, AND HEAVY EQUIPMENT DECONTAMINATION

STANDARD OPERATING PROCEDURE

1.0 Purpose

This Standard Operating Procedure (SOP) establishes guidelines for use by field personnel in the decontamination of drilling, development, and heavy equipment. The details within this SOP are applicable as general requirements for drilling and heavy equipment decontamination, and should also be used in conjunction with project work plans.

2.0 References

2.1 EPA, September 1987, EPA Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01.

2.3 SQP 4.2 - Records Management

2.4 SOP 6.1 - Sampling Equipment and Well Material Decontamination

3.0 Definitions

3.1 Laboratory Grade Detergent - A standard brand of laboratory-grade detergent, such as "Alconox" or "Liquinox."

3.2 Potable Water - Water dispensed from a municipal water system.

4.0 Procedure

4.1 Responsibilities

4.1.1 Compliance with this procedure is the responsibility of project management and field personnel. This SOP and the project work plans should be reviewed before implementing drilling, development, and heavy equipment decontamination at the project field area.

4.1.2 The Project Manager has the responsibility for ensuring that the decontamination of drilling and heavy equipment is properly performed through staff training and by maintaining quality assurance/quality control (QA/QC).

4.1.3 The Contractor Quality Control Manager (CQCM) has the responsibility for periodic review of procedures and documentation associated with the decontamination of drilling and heavy equipment. If perceived variances occur, the CQCM is also responsible for issuing notices of nonconformances and requesting corrective actions. Additionally, he/she will perform the three phases of inspections and continuous monitoring of the decontamination activities.

4.1.4 The project staff assigned to drilling, development, trenching, or construction activities are responsible for ensuring that subcontractors or equipment operators properly decontaminate the drilling, development, and heavy equipment associated with those tasks. The project staff are also responsible for documenting the decontamination activities on the Field Activity Daily Log (FADL) (Attachment 6.1) and/or appropriate form(s) as specified in the project work plans.

4.2 General

4.2.1 This section provides requirements for the set up of a decontamination facility for drilling, development, and heavy equipment and the decontamination procedures to be followed. The project work plans will provide specific information regarding:

- Types of equipment requiring decontamination under this SOP;
- Location of the decontamination station;

- Types and/or specifications on materials to be used in the fabrication of the decontamination station; and

- Types of materials and additional details on the procedures to be used in the decontamination process.

4.2.2 All field personnel associated with either the fabrication of the decontamination station or the decontamination of drilling or heavy equipment must read both this SOP and the project work plans prior to implementation of related decontamination activities. Information and requirements for the decontamination of any and all equipment used specifically for sampling is presented in SOP 6.1.

4.3 Decontamination Facility

4.3.1 A decontamination station will be set up in an area exclusively for decontamination of drilling, well development, and/or heavy equipment. The location of the decontamination station will be specified in the project work plans. All decontamination of drilling, development, and heavy equipment will be conducted within the station.

4.3.2 At a minimum, the station will be constructed such that all rinsates, liquid spray, soil, debris, and other decontamination wastes are fully contained and may be collected for appropriate waste management and disposal. The station may be as simple as a bermed, impermeable polyethylene sheeting, of sufficient thickness, with an impermeable sump for collecting rinse water. More sophisticated designs involving self-contained metal decontamination pads in combination with bermed polyethylene sheeting may also be used, depending on project-specific requirements. These requirements along with specific equipment and construction specifications for the decontamination station will be provided in the project work plans.

4.4 Decontamination of Downhole Equipment

4.4.1 All downhole drilling and development equipment (including but not limited to drill pipe, drive casing, drill rods, bits, tools, bailers, etc.) will be thoroughly decontaminated before mobilization onto each site and between borings or wells at each site or as required in the project work plans. The standard procedure will be performed as described below. Decontamination will be performed in accordance with this SOP and the project work plans.

4.4.2 Appropriate personal protective equipment (as specified in the project work plans) must be worn by all personnel involved with the task to limit personal exposure.

4.4.3 Equipment caked with drill cuttings, soil, or other material will initially be scraped or brushed. The scrapings will be containerized and appropriately disposed.

4.4.4 Equipment will then be sprayed with potable water using a hot water, high pressure washer.

4.4.5 Washed equipment will then be rinsed with potable water.

4.4.6 Decontaminated downhole equipment (such as drill pipe, drive casing, bits, tools, bailers, etc.) will be placed on clean plastic sheeting to prevent contact with contaminated soil and allowed to air dry. If equipment is not used immediately, it will be covered or wrapped in plastic sheeting to minimize airborne contamination.

4.4.7 Decontamination activities will be documented by the Site Superintendent, lead geologist, or lead engineer on the FADL and/or appropriate form(s), as specified in the project work plans.

4.5 Decontamination of Heavy Equipment

4.5.1 Heavy equipment (e.g., drill rigs, development rigs, backhoes, and other earthmoving equipment) will be decontaminated between drilling sites or inside the contaminant reduction area prior to entering and leaving an exclusion zone. Decontamination will be performed in accordance with the project work plans. The standard procedure will be performed as described below.

4.5.1.1 Appropriate personal protective equipment (as specified in the project work plans) will be worn by all personnel involved in the task, in order to limit personal exposure.

4.5.1.2 Equipment caked with drill cuttings, soil, or other material will be initially scraped or brushed. The scrapings will be containerized and appropriately disposed.

4.5.1.3 Equipment will then be sprayed with potable water using a hot water, high pressure washer.

4.5.1.4 Clean equipment will then be rinsed with potable water.

4.5.2 During the decontamination effort, fluid systems should be inspected for any leaks or problems which might potentially result in an inadvertent release at the site, thereby contributing to the volume of waste or contamination. Any identified problems should be immediately repaired and documented on the FADL. Decontamination should then be completed before moving the equipment onto the site or exclusion zone.

4.5.3 Decontamination activities will be documented by the Site Superintendent, lead geologist, or lead engineer on the FADL and/or appropriate form(s), as specified in the project work plans.

4.5.4 Between boreholes at the same site, the back-end of the drilling rigs will be washed with potable water until surfaces are visibly free of soil buildup.

5.0 Records

Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2.

6.0 Attachments

6.1 Field Activity Daily Log.

ATTACHMENT 6.1

FIELD ACTIVITY DAILY LOG

INTERNATIONAL TECHNOLOGY CORPORATION

FIELD ACTIVITY DAILY LOG

DAILY LOG			
DATE			
NO.			
SHEET OF			

PROJECT NAME	PROJECT NO.
FIELD ACTIVITY SUBJECT:	
DESCRIPTION OF DAILY ACTIVITIES AND EVENTS:	
VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS.
WEATHER CONDITIONS:	IMPORTANT TELEPHONE CALLS:
IT PERSONNEL ON SITE:	
SIGNATURE	DATE:

MONITORING WELL INSTALLATION

STANDARD OPERATING PROCEDURE

1.0 Purpose

This Standard Operating Procedure (SOP) provides procedures and requirements for the installation of monitoring wells using rotary, dual-tube percussion, or hollow-stem auger drilling techniques. The details within this SOP should be used in conjunction with specific project work plans.

2.0 References

2.1 U.S. Environmental Protection Agency (EPA), Manual of Water Well Construction Practices, U.S. Environmental Protection Agency, Office of Water Supply, U.S. Government Printing Office, Washington D.C.

2.2 U.S. Environmental Protection Agency (EPA), 1986, Resource Conservation and Recovery Act (RCRA) Ground Monitoring Technical Enforcement Guidance Document, OSWER-9950.1, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, U.S. Government Printing Office, Washington D.C.

2.3 U.S. Environmental Protection Agency (EPA), 1987, A Compendium of Superfund Field Operations Methods, EPA-500/P-87/001, U.S. Government Printing Office, Washington D.C.

2.4 SOP 6.1 - Sampling Equipment and Well Material Decontamination

2.5 SOP 6.2 - Drilling and Heavy Equipment Decontamination

2.6 SOP 14.1 - Hollow Stem Auger Drilling

2.7 SOP 14.2 - Mud Rotary Drilling

2.8 SOP 14.3 - Air Rotary Drilling

2.9 SOP 14.4 - Dual Tube Percussion Drilling

2.10 SOP 15.1 - Lithologic Logging

2.11 SOP 16.1 - Filter Pack and Well Screen Slot Size Determination

2.12 SQP 4.2 - Records Management

2.13 SQP 8.2 - Calibration and Maintenance of Measuring and Test Equipment

3.0 Definitions

3.1 Cuttings

Pieces of soil, sediment, or rock cut by a bit in the process of drilling borings.

3.2 Borehole

Any hole drilled into the subsurface for the purpose of identifying lithology, collecting soil samples, and/or installing groundwater wells.

3.3 Grout

For the purposes of this SOP, the term "grout" consists of a neat cement grout generally containing three to five percent bentonite powder to water by weight. The grout is emplaced as a slurry, and once properly set and cured, is capable of restricting movement of water.

3.4 Hollow-Stem Auger Drilling

A drilling method using augers with open centers. The augers are advanced with a screwing or rotating motion into the ground. Cuttings are brought to the surface by the rotating action of the augers, thereby clearing the borehole.

3.5 Air Rotary Casing Hammer Drilling

A drilling method using a nonrotating drive casing that is advanced simultaneously with a slightly smaller diameter rotary bit attached to a string of drill pipe. The drive casing is a heavy-walled, threaded pipe that allows for pass-through of the rotary drill bit inside the center of the casing. Air is forced down through the center drill pipe to the bit, and then upward through the space between the drive casing and the drill pipe. The upward return stream removes cuttings from the bottom of the borehole.

3.6 Mud Rotary Drilling

For the purposes of this monitoring well installation SOP, the term "mud rotary drilling" refers to direct circulation (as opposed to reverse circulation) mud rotary drilling. Mud rotary drilling uses a rotating drill bit which is attached to the lower end of a string of drill pipe. Drilling mud is pumped down through the inside of the drill pipe and out through the bit. The mud then flows upward in the annular space between the borehole and the drill pipe, carrying the cuttings in suspension to the surface.

3.7 Dual-tube Percussion Drilling

A drilling method using nonrotating drive casing with a bit on the bottom of the casing string. A smaller diameter tube or drill pipe is positioned inside the drive casing. The drive casing is advanced by the use of a percussion hammer, thereby causing the bit to cut or break up the sediment or soil at the bottom of the boring. Air is forced down the annular space between the drive casing and inner drill pipe and cuttings are forced up the center of the inner drill pipe.

3.8 Monitoring Well

A well that provides for the collection of representative groundwater samples, the detection and collection of representative light and dense nonaqueous phase organic liquids, and the measurement of fluid levels.

3.9 Annular Space

The space between:

- Concentric drill pipes;

- An inner drill pipe and outer drive casing;
- Drill pipe or drive casing and the borehole wall; or
- Well screen or casing and the borehole wall.

3.10 Filter Pack

Granular filter material (sand, gravel, etc.) placed in the annular space between the well screen and the borehole to increase the effective diameter of the well and prevent fine-grained material from entering the well.

3.11 Well Screen

A perforated, wire wound, continuous wrap or slotted casing segment used in a well to maximize the entry of water from the producing zone and to minimize the entrance of sand.

3.12 Tremie

A tubular device or pipe used to place grout, bentonite, or filter pack in the annular space.

4.0 Procedure

This section contains both main responsibilities and procedures for monitoring well installation activities. The procedures described herein are applicable as requirements for monitoring well installations using mud rotary, air rotary, air rotary casing hammer, dual tube percussion, or hollow-stem auger drilling techniques. Site-specific factors need to be considered in the selection of well construction and completion materials, specification of well designs, and choosing well drilling methods. These factors will be incorporated in project planning activities and the compilation of specific project work plans. The project work plans will contain the following information related to monitoring well installation:

- Objectives of the monitoring well
- Specific location of the well to be installed
- Zone or depth well is to be installed
- Drilling method(s) to be used
- Well construction materials to be used

- Specification of well design(s) including Well Construction Diagrams (Attachment 6.1)

- Additional procedures or requirements beyond this SOP.

4.1 Responsibilities

4.1.1 The Delivery Order Manager is responsible for ensuring that all monitoring well installation activities are conducted and documented in accordance with this and any other appropriate procedures. This will be accomplished through staff training and by quality assurance/quality control (QA/QC) monitoring activities.

4.1.2 The Contractor Quality Control Manager (CQCM) is responsible for periodic review of well installation activities to assure implementation of this SOP. The CQCM is also responsible for the review and approval of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to monitoring well installation requirements, issuing nonconformances, etc.) identified during the performance of these activities.

4.1.3 Field personnel assigned to monitoring well installation activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the Site Superintendent, Project Manager, or the CQCM.

4.2 Well Installation Procedures

4.2.1 Before mobilization of a rig to the well site, ensure that the monitoring well location has been appropriately cleared of all underground utilities, buried objects, and drill permits have been issued per the project work plans. Review all forms and diagrams documenting the location of the cleared monitoring well site and the location of any identified underground utility lines or other buried objects.

4.2.2 Decontaminate all downhole equipment and well construction materials before monitoring well installation, as described in SOP 6.1. Decontaminate the drilling rig and all drilling equipment before monitoring well installation per SOP 6.2.

4.2.3 Clear the work site of all brush and minor obstructions and then mobilize the rig to the monitoring well location. The rig geologist or engineer should then review with the driller the proposed well design and details of the well installation including any anticipated potential drilling or completion problems.

4.2.4 Calibrate health and safety monitoring equipment according to the instrument manufacturer's specifications. Document the calibration results on the appropriate form(s), as specified by SQP 8.2. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

4.2.5 Workers will be provided with, and don, the appropriate personal protective equipment as specified by the project work plans. Typically, the minimum personal protection will include a hard hat, safety glasses, gloves, steel-toed boots, hearing protection, and coveralls.

4.2.6 Commence drilling and advance the borehole while conducting health and safety monitoring according to the project work plans. Perform readings as often as necessary to ensure the safety of workers. Record all measurements on the Field Activity Daily Log (FADL) (Attachment 6.2) and/or other appropriate form(s) as specified in the project work plans. Record all other pertinent information (date, site, well or boring number, and location) on the FADL and/or on other appropriate form(s) as specified by the project work plans. Also note and record observed field conditions, any unusual circumstances, and weather conditions. Drilling of the borehole should be conducted in conformance with SOPs 14.1, 14.2, 14.3, or 14.4, as appropriate.

4.2.7 During drilling, collect representative cutting and soil samples as required by the project work plans. Compile a boring or lithologic log from the cuttings and samples per SOP 15.1.

4.2.8 At total depth, remove soil cuttings through circulation or rapidly spinning the augers prior to constructing the well. Review logs and notes with the driller for any zones or depths exhibiting drilling problems which may affect the well installation. Condition the hole or take other actions mutually agreed upon by the rig geologist (or engineer), lead technical personnel, and the driller to ensure or aid in the well development.

4.2.9 Remove the drill pipe and bit if using rotary techniques, or remove the center bit boring if using the hollow-stem auger technique. The well construction materials will then be installed inside the open borehole or through the center of the drive casing or augers.

4.2.10 Measure the total depth of the completed boring using a weighted sounding line. The borehole depth is checked to assure that formation material has not heaved to fill the borehole. If heaving has taken place, options for cleaning, redrilling, or installation in the open section of the boring should be discussed with lead technical personnel.

4.2.11 In the event that the hole was over-drilled, grout, bentonite pellets, or bentonite chips (as specified in the project work plans) may be added to the bottom of the boring to raise the bottom of the hole to the desired depth. The grout should be pumped through a tremie pipe and fill from the bottom of the boring upward. During grouting, the tremie pipe should be submerged below the top of the grout column in the borehole to prevent free-fall and bridging. If bentonite is used, it should be added gradually to prevent bridging. Grout or bentonite addition will stop when its level has reached approximately one foot below the desired base of the well string (casing, screen, end plug or sump, etc.). The bentonite plug will be hydrated for at least one hour before installation of a filter pack.

4.2.12 Calculate volumes of filter pack, bentonite pellets/slurry, and grout required, based on borehole and well casing dimensions. If required by the project work plans, determine the filter pack and well screen slot size for the monitoring well per SOP 16.1.

4.2.13 Place a layer of filter pack (one to two feet, unless otherwise specified in the project-specific work plans) at the bottom of the borehole. The filter pack will be installed through the center of the drive casing/augers. Filter pack will be added slowly while withdrawing the drive casing/augers.

4.2.14 Inspect the casing, screen, and any other well construction materials prior to installation to assure that no damage has occurred during shipment and decontamination activities.

4.2.15 Connect and carefully lower the well string through the open borehole; drive casing, or inside of the augers until the well string is at the desired depth. The well string should be suspended by the installation rig and should not rest on the bottom of the boring. In the event the well string was dropped, lowered abruptly, or for any other reason suspected of being damaged during placement, the string should be removed from the boring and inspected. In certain instances, the well string may rise after being placed in the borehole due to heaving sands. If this occurs, the driller must not place any drilling equipment (drill pipe, hammers, etc.) to prevent the casing from rising. The amount of rise should be noted by the rig geologist or engineer who should then consult lead technical personnel for an appropriate course of action.

4.2.16 Record the following information on the Well Completion Form (Attachment 6.3) and/or other appropriate forms per the project work plans:

- Length of well screen
- Total depth of well boring
- Depth from ground surface to top of grout or bentonite plug in bottom of borehole (if present)
- Depth to base of well string
- Depth to top and bottom of well screen.

4.2.17 When using the mud rotary drilling technique, tremie the filter pack into the annular space around the screen. Clean, potable water may be used to assist with the filter pack tremie operation. For all other drilling techniques, the filter pack may be allowed to free fall or be tremied per the project work plans. If using drive casing or augers, the drive casing or augers should be pulled slowly during filter pack installation in increments no greater than five feet.

4.2.18 Filter pack settlement should be monitored by initially measuring the sand level (before beginning to withdraw the drive casing/augers). In addition, depth soundings using a weighted tape shall be taken repeatedly to continually monitor the level of the sand. The top of the well casing shall also be monitored to detect any movement due to settlement or from drive casing/auger removal. If the top of the well casing moves upwards at any time during the well installation process, the driller should not be allowed to set drilling equipment (downhole hammers, drill pipe, etc.) on the top of the casing to prevent further movement.

4.2.19 Filter pack should be added until its height is approximately two feet above the top of the screen (unless otherwise specified in the project work plans), and verification of its placement (by sounding) should be conducted. The filter pack should then be gently surged using a surge block or swab in order to settle the pack material and reduce the possibility of bridging.

4.2.20 The height of the filter pack will then be re-sounded and additional filter pack placed as necessary. Once the placement of the filter pack is completed, the depth to the top of the pack is measured and recorded on the Well Completion Form (Attachment 6.3) or other appropriate forms per the project work plans.

4.2.21 A three-foot thick (unless otherwise specified in the project work plans) bentonite seal is then installed on top of the filter pack. If pellets or chips are used, they should be added gradually to avoid bridging. Repeated depth soundings will be taken using a weighted tape to ascertain the top of the bentonite seal. The seal should be allowed to hydrate for at least one hour before proceeding with the grouting operation.

4.2.22 After hydration of the bentonite seal, grout is then pumped through a tremie pipe and filled from the top of the bentonite seal upward. The bottom of the tremie pipe should be maintained below the top of the grout to prevent free fall and bridging. When using drive casing or hollow-stem auger techniques, the drive casing/augers should be raised in incremental intervals, keeping the bottom of the drive casing/augers below the top of the grout. Grouting will cease when the grout level has risen to within approximately one to two feet of the ground surface, depending on the surface completion type (flush mount versus aboveground). Grout levels should be monitored to assure that grout taken into the formation is replaced by additional grout. If settling of the grout occurs, additional topping off of the grout may be necessary.

4.2.23 For aboveground completions, the protective steel casing will be centered on the well casing and inserted into the grouted annulus. Prior to installation, a 2-inch deep temporary spacer shall be placed between the PVC well cap and the bottom of the protective casing cover to keep the protective casing from settling onto the well cap.

4.2.24 After the protective casing has set, a drainage hole may be drilled into the protective casing if required by the project work plans. The drainage hole is positioned approximately two inches above ground surface. The protective casing will be painted with a rust-preventive colored paint.

4.2.25 The well head will be labeled to identify, at a minimum, the well number, depth, and date of installation.

4.2.26 A minimum of 24 hours after grouting should elapse before installation of the concrete pad and steel guard posts for aboveground completions, or street boxes or vaults for flush mount completions.

4.2.27 For aboveground completions, a concrete pad, usually 3-foot by 3-foot by 4-inch thick, is constructed at ground surface around the protective steel casing. The concrete is sloped away from the protective casing to promote surface drainage from the well.

4.2.28 For aboveground completions, where traffic conditions warrant extra protection, three steel bucking posts will be embedded to a depth approximately 1.5 feet below the top of the concrete pad. The posts will be installed in concrete filled post holes spaced equally around the well at a distance of approximately 1.5 feet from the protective steel casing. Where removal of bucking posts is required for well access, mounting sleeves should be imbedded into the concrete.

4.2.29 For flush mount (or subgrade) completions, a street box or vault is set and cemented in position. The top of the street box or vault will be raised slightly above grade and the cement sloped to grade to promote surface drainage away from the well.

4.2.30 Following well completion and demobilization of the rig, the well site should be cleared of all debris and trash and restored to a neat and clean appearance per the project work plans. All investigation-derived waste generated at the well site should be appropriately contained and managed per the project work plans.

5.0 Records

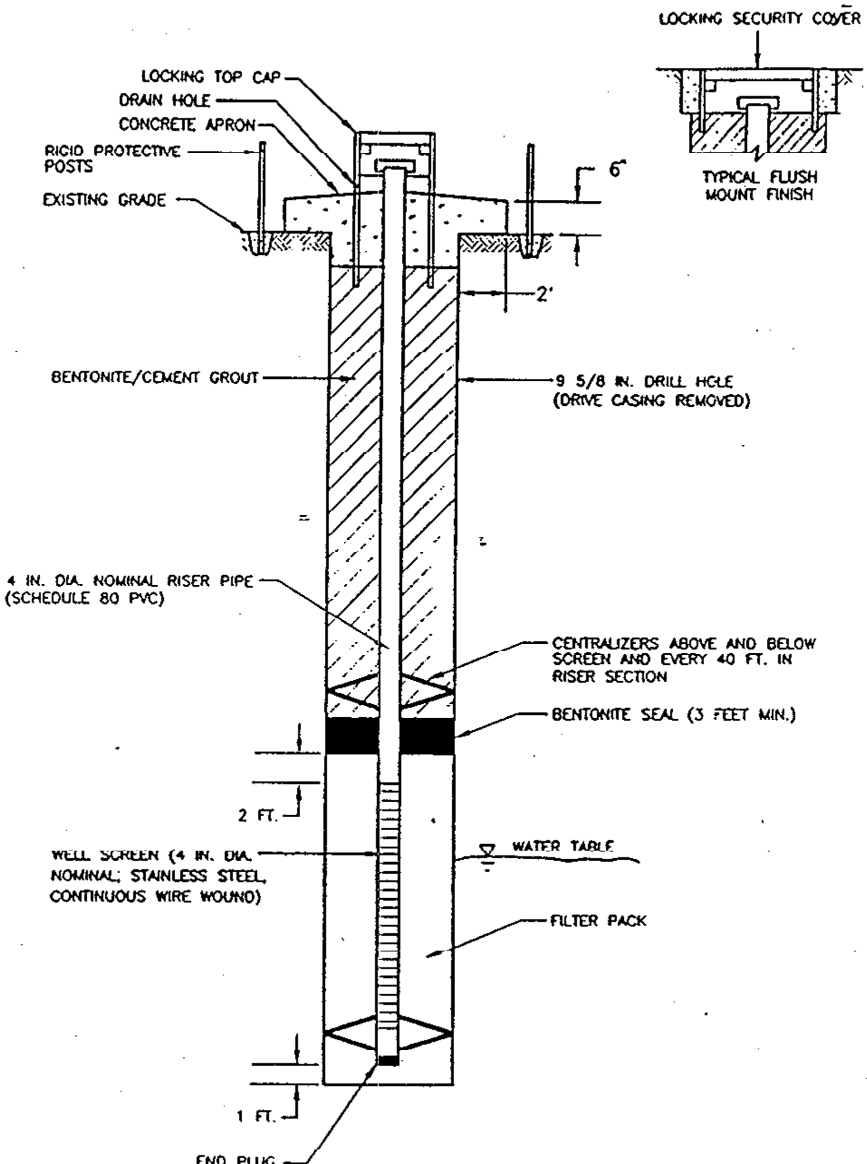
Records generated as a result of implementation of this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2.

6.0 Attachments

6.1 Example Well Construction Diagram
6.2 Field Activity Daily Log
6.3 Example Well Completion Form

ATTACHMENT 6.1

EXAMPLE WELL CONSTRUCTION DIAGRAM



WATER TABLE WELL
CONSTRUCTION DIAGRAM

NOT TO SCALE

IT INTERNATIONAL TECHNOLOGY CORPORATION

ATTACHMENT 6.2

FIELD ACTIVITY DAILY LOG

INTERNATIONAL TECHNOLOGY CORPORATION

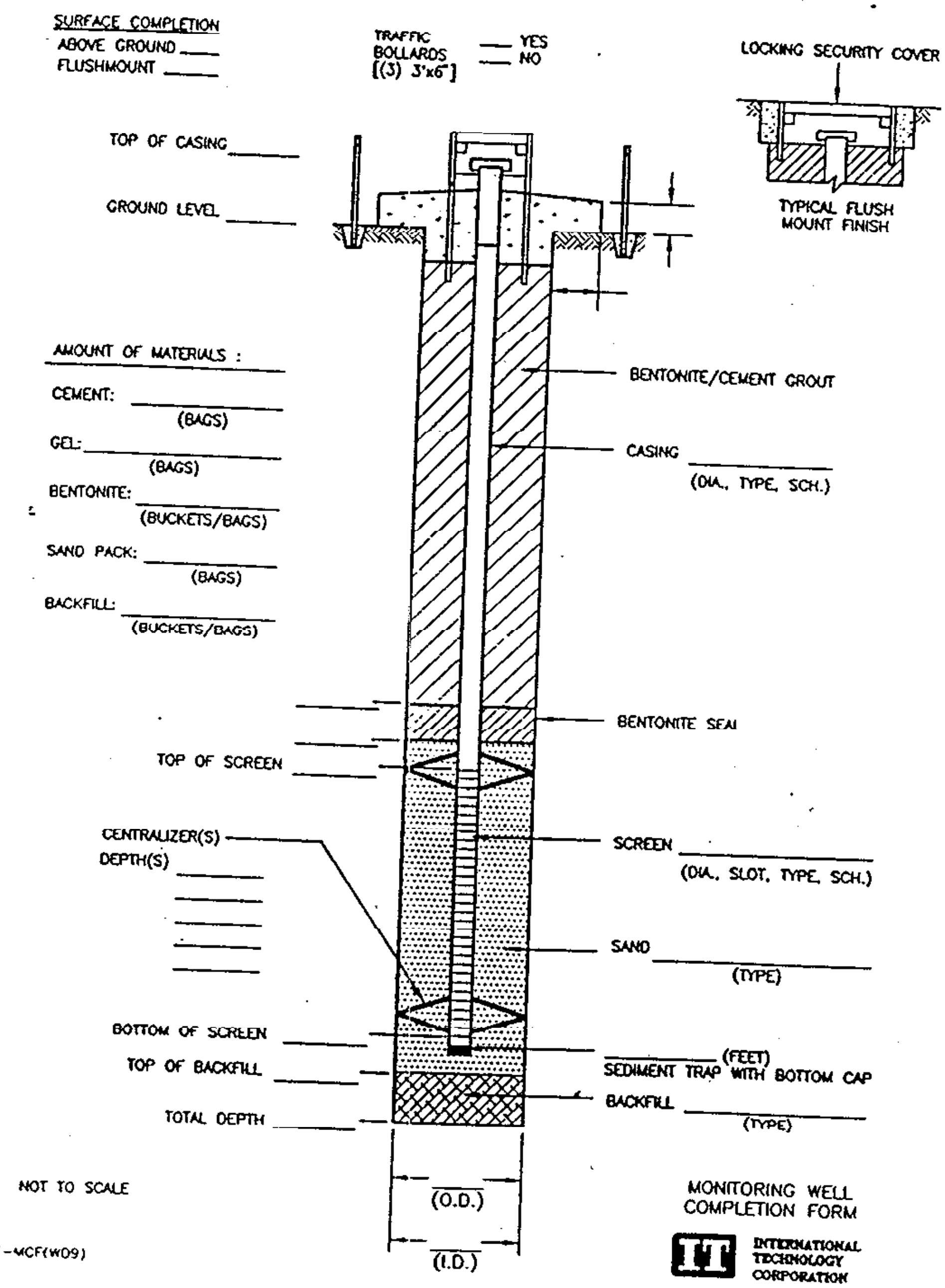
FIELD ACTIVITY DAILY LOG

DAILY LOG			
DATE			
NO.			
SHEET		OF	

PROJECT NAME	PROJECT NO.
FIELD ACTIVITY SUBJECT:	
DESCRIPTION OF DAILY ACTIVITIES AND EVENTS:	
VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS.
WEATHER CONDITIONS:	IMPORTANT TELEPHONE CALLS:
IT PERSONNEL ON SITE:	
SIGNATURE	DATE:

ATTACHMENT 6.3

EXAMPLE WELL COMPLETION FORM



MONITORING WELL DEVELOPMENT

STANDARD OPERATING PROCEDURE

1.0 Purpose

This Standard Operating Procedure (SOP) establishes guidelines for specifying, assessing and documenting the well development process. Additional specific well development procedures and requirements will be provided in the project work plans.

2.0 References

2.1 SOP 5.1 - Water Level Measurements in Monitoring wells

2.2 SOP 6.1 - Sampling Equipment and Well Material Decontamination

2.3 SOP 6.2 - Drilling and Heavy Equipment Decontamination

2.4 SQP 4.2 - Records Management

2.5 SQP 8.2 - Calibration and Maintenance of Measuring and Test Equipment

2.6 U.S. Environmental Protection Agency (EPA), August 1988, Guidance for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01.

2.7 U.S. Environmental Protection Agency (EPA), 1987, A Compendium of Superfund Field Operations Methods, EPA-540/P-87/001a, U.S. Government Printing Office, Washington D.C.

2.8 ASTM, 1988, Standards Technology Training Program - Groundwater and Vadose Zone Monitoring, Nielsen, et al.

3.0 Definitions

3.1 Well Development - The act of removing fine grained sediment and drilling fluids from the sand pack and formation in the immediate vicinity of the well, thus increasing the porosity and permeability of the materials surrounding the intake portion of the well.

3.2 Educator Pipe - The pipe used to transport well discharge water to the surface.

4.0 Procedure

4.1 General

4.1.1 The most common methods used to develop monitoring wells consist of surging and bailing, surging and pumping, or combinations of all these.

4.1.2 The project work plans will identify the specific well development procedure to be followed. The standard procedure for field personnel to use in assessing and documenting well development is described below and is intended only for development methods listed above.

4.2 Responsibilities

4.2.1 The Delivery Order Manager is responsible for ensuring that monitoring wells are properly developed and that the development process is properly documented. This will be accomplished by staff training and by maintaining quality assurance/quality control (QA/QC).

4.2.2 The Contractor Quality Control Manager (CQCM) is responsible for periodic review of field generated documentation associated with well development. If deviations from project requirements occur, the CQCM is also responsible for issuing notices of nonconformances and requests for corrective action.

4.2.3 Field personnel are responsible for conducting monitoring well development and documentation in accordance with the specifications outlined in this SOP and by the project work plans.

4.3 Well Development

4.3.1 Decontaminate the rig and development equipment in accordance with SOPs 6.1 and 6.2, respectively.

4.3.2 Calibrate all field analytical test equipment (pH, temperature, conductivity, turbidity) according to the instrument manufacturer's specifications and SQP 8.2. Specific test equipment to be used should be identified in the project-specific work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service, tagged with an out of calibration label, and segregated (when possible) from the calibrated equipment area.

An exception to the daily calibration requirements will be made in the case of the water level meters. The tape of these instruments will be checked prior to the beginning of the project and each succeeding six months using a steel surveyor's tape.

4.3.3 Visually inspect the well to ensure that it is undamaged, properly labelled and secured. Any observed problems with the well head should be noted in the Field Activity Daily Log and reported to the Site Superintendent.

4.3.4 Unlock the well and obtain a depth to water level measurement according to the procedures outlined in SOP 5.1. Calculate the volume of water in the well (cased well volume) as follows:

$$\left(\frac{d}{2}\right)^2 \times (h_1 - h_2) \times 0.163 = \text{gallons per cased well volume}$$

where

d = inside diameter of well casing
h_1 = depth of well from top of casing
h_2 = depth to water from top of casing.

4.3.5 The depth to the bottom of the well should be sounded and then compared to the completion form or diagram for the well. If sand or sediment are present inside the well, it should first be removed by bailing. Do not insert bailers, pumps, or surge blocks into the well if obstructions, parting of the casing, or other damage to the well is suspected. Instead report the conditions to the Site Superintendent and obtain approval to continue or cease well development activities.

4.3.6 Begin development by first gently surging followed by bailing or pumping. This is then continued with alternate surging and bailing or pumping. At no time should the surge block be forced down the well if excessive resistance is encountered. During development, the bailer should not be allowed to free-fall or descend rapidly such that it becomes lodged in the casing or damages the end cap or sediment trap at the bottom of the well.

4.3.7 While developing, take periodic water level measurements (at least one every five minutes) to determine if drawdown is occurring and record the measurements on the Well Development Record (Attachment 1).

4.3.8 While developing, calculate the rate at which water is being removed from the well. Record the volume on the Well Development Record.

4.3.9 While developing, water is also periodically collected directly from the eductor pipe or bailer discharge and readings taken of the indicator parameters: pH, specific conductance, and temperature. Development is considered complete when the indicator parameters have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans) and a minimum of three well volumes of water have been removed. In certain instances, for slow recharging wells, the parameters may not stabilize. In this case, well development is considered complete upon removal of the minimum of three well volumes. In some cases, the project work plans may also specify a maximum turbidity requirement for completion of development.

4.3.10 Obtain a water level and turbidity measurement at the completion of development.

4.3.11 Complete documentation of the well development event on the Well Development Record form. At a minimum this record must contain:

- Project name and number
- Well identification number
- Well depth, casing size, and completion date
- Method of development
- Volume of water removed
- Water levels (including the time of measurement)
- Physical description of the water (e.g., discoloration, turbidity, odor, etc.) and solids removed from the well
- Test equipment readings for pH, conductivity, temperature and turbidity (including the time of collection)
- Signature of the well development observer.

4.3.12 Collect and appropriately transport and dispose of water removed from the well in accordance with criteria listed in the project-specific work plans and regulatory requirements.

4.3.13 Allow the well to recover for at least 24 hours prior to sampling.

5.0 Records

Records generated as a result of implementing this SOP will be controlled and maintained in the project record files in accordance with SQP 4.2.

6.0 Attachments

6.1 Well Development Record form

ATTACHMENT 6.1

WELL DEVELOPMENT RECORD

INTERNATIONAL TECHNOLOGY CORPORATION

Page 1 of ____

WELL DEVELOPMENT RECORD
D.O. NO. ____________

Location: ____________________ Well/Piez. No.: ____________________

Personnel: ____________________ Date Installed: ____________________

Date: ____________________ Csg. Diameter (I.D.): ____________

Method of Development: Total Depth (ft. BGL): ____________

☐ Surging ☐ Bailing ☐ Pumping

Weather: ____________________ Screened Interval (ft. BGL): ____________

Equipment Nos.: pH Meter ________ EC Meter ______ Turbidity Meter ______

Equipment decontaminated prior to development Y _____ N _____

Describe ____

Date	Time	Water Level (ft. BGL)	Volume Removed (gal.)	Temp (°C)	pH	EC	Turbidity	Comments

- Water levels – Reported to the nearest 0.01 foot.
- pH – Reading rounded to 0.1 pH units
- Electrical conductivity – Reported to the nearest 10% mhos/cm of instrument set range
- Water temperature – Reported to nearest 0.1°C

UD-WDVR(VD41)

ATTACHMENT 6.1

WELL DEVELOPMENT RECORD
(CONTINUED)

INTERNATIONAL TECHNOLOGY CORPORATION

WELL DEVELOPMENT RECORD
CONTINUATION SHEET
D.O. NO. ____________

PROJECT NO. ________
WELL/PIEZ. NO. _____
PAGE _____ NO. _____

Date	Time	Water Level (ft. BGL)	Volume Removed (gal.)	Temp (°C)	pH	EC	Turbidity	Comments

WD-WDVRC(WD4)

MUD ROTARY DRILLING

STANDARD OPERATING PROCEDURE

1.0 Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for field personnel to use during the supervision of drilling operations involving mud rotary techniques. Additional specific mud rotary drilling procedures and requirements will be provided in the project work plans.

2.0 References

2.1 SOP 3.2 - Subsurface Soil Sampling While Drilling

2.2 SOP 6.1 - Sampling Equipment and Well Material Decontamination

2.3 SOP 6.2 - Drilling and Heavy Equipment Decontamination

2.4 SOP 8.1 - Monitoring Well Installation

2.5 SOP 8.3 - Borehole and Well Abandonment

2.6 SOP 15.1 - Lithologic Logging

2.7 SOP 4.2 - Records Management

3.0 Definitions

3.1 Mud Rotary Drilling

A drilling technique that uses a fluid, usually water with bentonite or polymer, pumped down through drill pipe and out through a rotating drill bit attached to the lower end of the drill string. This "mud" mixture cools the drill bit, jets cuttings away from the bit face and flows upward in the annular space between the borehole and the drill pipe, carrying the cuttings in suspension to the surface.

A similar drilling technique referred to as "reverse circulation mud rotary" involves circulating mud down the annular space of the wellbore and back up through the drill pipe. This technique is not specifically discussed in this SOP.

A variety of different drill bits are available for mud rotary drilling. The type of bit used for a particular borehole depends upon the type of subsurface formation encountered. Button or cone type drilling bits are typically used to drill through granular soils, including coarse gravels. Bladed "drag" or "fishtail" type bits are commonly used to penetrate through clayey and silty soils. Some consolidated gravels and hard bedrock may require diamond bits or be too dense for adequate penetration rates.

3.1.1 Advantages

Mud rotary drilling advantages include rapid penetration of most hard soils, hardpans and gravelly soils, and penetration to depths in excess of 100 feet. Mud rotary drilling may be the technique of choice where depth requirements are beyond the range of auger drilling, drive casing methods are not feasible, or mud is required to maintain hole stability. Mud rotary methods are generally suitable for unconsolidated and consolidated soils and casing is usually not required for borehole stability. The open fluid-filled wellbore is ideal for borehole geophysical logging. Soil sampling is reliable and continuous core can be taken in most subsurface geologic units.

3.1.2 Disadvantages

Mud rotary drilling disadvantages are related to the use of drilling mud as a circulating medium. Drilling mud is usually a suspension of bentonite, water and additives requiring regular monitoring to maintain fluid weight, density, and viscosity. The mud invades pore spaces and mixes with formation fluids in the process of drilling, thereby causing "formation damage" and reducing well yield. Mud invasion makes identification of the water table and water bearing zones particularity difficult during drilling. Drilling muds can degrade groundwater and may provide a pathway for contamination across aquifers. Very loose soils may cave during drilling and continual mud circulation may cause excessive wellbore enlargement or "washouts". Bentonite complicates chemical analyses, particularity for metals, and may clog the sand packs in monitoring wells. Drilling fluids must be contained during drilling and require analysis after completion to determine disposal methods.

3.1.3 Additional Considerations

Soil cuttings are disaggregated by drilling making bedding and fabric determination difficult at best. The cuttings are typically saturated or coated with mud, requiring washing with water in a screen or sieve. See SOP 15.1 for additional remarks related to lithologic logging of soil cuttings.

Soil samples can be obtained from the bottom of the hole but sampling typically requires removing the entire drill string and sending the sampler through drilling mud. Mud rotary methods are not recommended when significant soil sampling or sampling for analytical parameters are required. This method can be used to install monitoring and pumping (extraction) wells. However, wells installed by this method require extensive development and may still have relatively low specific capacities due to formation damage.

4.0 Procedure

This section contains responsibilities, requirements, and procedures for mud rotary drilling. The selection and implementation of mud rotary drilling techniques must incorporate site-specific conditions and requirements. Consequently, project work plans will identify the following:

- The purpose of each borehole (eg., monitoring well installation, geophysical logging, coring or soil sampling, etc.)
- Specific methodology for drilling, including equipment, mud type(s), and cuttings/fluid containment
- Specific locations, depths, and diameters of boreholes
- Type of sampling and/or logging of borehole

- Details of mobilization/demobilization and decontamination of equipment
- Appropriate health and safety guidelines and personal protective equipment
- Additional mud rotary drilling requirements or procedures beyond those covered in this SOP

4.1 Responsibilities

4.1.1 The Project Manager is responsible for ensuring that all mud rotary drilling is conducted and documented in accordance with this and any other appropriate procedures. This will be accomplished by staff training and by maintaining quality assurance/quality control (QA/QC).

4.1.2 The Contractor Quality Control Manager (CQCM) is responsible for periodic review of field activities and the resulting documentation generated from this SOP. The CQCM is also responsible for the implementation of corrective action (retraining personnel, additional review of work plans and SOPs, variances to mud rotary drilling supervision requirements, issuing nonconformances, etc.) if problems occur.

4.1.3 Field personnel assigned to supervise mud rotary drilling are responsible for completing their tasks according to this and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the Site Superintendent or the CQCM.

4.2 Equipment Requirements and Considerations

4.2.1 Rigs used for mud rotary drilling shall be of sufficient horsepower, torque and hoisting capacity to drill boreholes of anticipated diameter to anticipated maximum depths, as specified in the project work plans.

4.2.2 Drill rigs should preferably be self propelled or capable of accessing anticipated site field conditions.

4.2.3 Mud pits should be of sufficient volume to allow for adequate circulation of the drilling fluids. Portable mud pits with a "U" shaped arrangement or comprised of two separate tanks are preferred.

4.2.4 The drilling fluid conveyance system from the mud pits to the drill pipe should be entirely enclosed and fluid tight to minimize exposure of the drill crew to contaminated drilling mud.

4.2.5 Return drilling mud should be conveyed from the borehole to a shaker by a method that is fluid tight and does not allow cuttings to settle along the way. This shall be an entirely enclosed hose or pipeline.

4.2.6 The shaker is to be constructed and set up at each drilling site such that a field representative can easily reach across the top of the shaker screen to collect cuttings samples. The shaker screen should be of the correct type and mesh. Window screen is not acceptable.

4.2.7 Only preapproved additives may be used in the drilling mud. The additives must also meet regulatory requirements specific to the site and described in the project work plans.

4.2.8 Only Teflon™ based thread compound may be used to lubricate drill pipe threads. No other compound may be used.

4.2.9 Drill bit bearings and teeth should be in first class operating condition. Proper types of bits, slips, collars and subs are to be available at sizes needed to drill the desired diameters in the formation to be encountered.

4.3 Drilling Site Mobilization

4.3.1 Rig Decontamination and Preparation

4.3.1.1 All drilling and sampling equipment should be decontaminated before drilling as per SOPs 6.1 and 6.2, and the project work plans.

4.3.1.2 The driller and the rig geologist/engineer should inspect the drilling equipment for proper maintenance and appropriate decontamination. All clutches, brakes, rotary tables, swivels, kellys and drive heads should be in proper working order. All cables, hydraulic hoses, mud pumps and shakers should be in good condition. All pipe joints and bits should be in good condition with no worn threads, cracked tool joint connections or excessive wear etc.

4.3.1.3 Any excessive leakage of fluids from the rig or fluid circulation system (e.g., portable mud pits, mud pumps, hoses, etc.) should be immediately repaired and the rig or circulation equipment decontaminated again before it is allowed to mobilize to the site.

4.3.2 Site Preparation

4.3.2.1 The logistics of drilling, logging, sampling, cuttings/fluid containment, and/or well construction should be determined before mobilizing. The site should be prepared as per project work plans.

4.3.2.2 Before mobilization, the Site Superintendent and/or the rig geologist/engineer should assess the drilling site. This assessment should identify potential hazards (slip/trip/fall, overhead, etc.), and determine how drilling operations may impact the environment (dust, debris, noise). Potential hazards should be evaluated and corrected, or the borehole location changed or shifted as per the project work plans.

4.3.2.3 The Site Superintendent or appropriate designee should ensure that all identifiable underground utilities around the drilling location have been marked and the borehole location cleared as per project work plans. At a minimum, copies of the site clearance documents should be kept on-site in a common accessible location.

4.3.3 Mobilization and Set-up

4.3.3.1 Once site preparation is completed, the rig is mobilized to the site and positioned over the identified borehole location. The rig is then leveled with a set of hydraulic pads at the front and rear of the equipment. Once the rig is levelled, the mast should be raised slowly and carefully to prevent tipping or damaging the rig and to avoid hitting any obstructions or hazards.

4.3.3.2 Appropriate barriers and markers should be in place prior to drilling, as per the site health and safety plan. Visqueen (plastic) may be required beneath the rig and mud circulation system.

4.3.3.3 Appropriate fluids, cuttings, and other investigation-derived waste containment should be set up on site prior to the commencement of drilling.

4.3.4 Health and Safety Requirements

4.3.4.1 Tailgate Safety Meetings should be held in the manner and frequency stated in the health and safety plan. All IT and subcontractor personnel at the site should have appropriate training and qualifications as per the health and safety plan. Documentation should be kept readily available in the project files on site.

4.3.4.2 During drilling, all personnel within the exclusion zone should pay close attention to all rig operations. Rapidly rotating drill tools can catch or snag loose clothing causing serious injury.

4.3.4.3 Establishing clear communication signals with the drilling crew is mandatory since verbal signals may not be heard during the drilling process.

4.3.4.4 The entire crew should be made aware to inform the site supervisor of any unforeseen hazard, or when anyone is approaching the exclusion zone.

4.4 Drilling Procedures

4.4.1 Breaking Ground and Surface Hole Drilling

4.4.1.1 Prior to the commencement of drilling, all safety sampling and monitoring equipment will be appropriately calibrated as per the project work plans. The rig geologist/engineer should inform the driller of the appropriate equipment (cookie cutter etc.) to be used for penetrating the specific surface cover (asphalt, concrete cement etc.) at the drilling location.

4.4.1.2 The upper or "surface hole" portion (first 5-20 feet below ground surface) of a mud rotary borehole is commonly drilled with the auger or air rotary drilling method in order to set a temporary conductor casing. The conductor casing is used to keep the upper portion of the hole open and to prevent drilling mud from channeling to the surface through shallow unconsolidated soils. The length of the conductor casing depends in part on the consolidation and permeability of the shallow subsurface soils. If geophysical logging is planned, the conductor pipe should only be as long as is necessary to keep the upper part of the hole open.

4.4.1.3 In the event of breaking ground where a shallow subsurface hazard may exist (unidentifiable utility, trapped vapors, etc.), the driller should be informed of the potential hazard. Drilling of the surface hole should commence slowly to allow continuous visual inspection and, if necessary, any interruptions for probing until the anticipated maximum depth of any suspected obstructions is exceeded.

4.4.1.4 Once the surface hole is drilled to the necessary depth, the conductor casing is then set in the borehole and the mud rotary drilling equipment is then set up for further drilling. Before commencement of mud rotary drilling, the drilling fluid or mud should be "made up" in the mud pits. The drilling mud properties (as specified in the project work plans) should then be verified to the satisfaction of the rig geologist/engineer before allowing drilling to proceed. These observations should also be documented by the rig geologist/engineer on the Field Activity Daily Log (FADL) (Attachment 6.1).

4.4.2 Mud Rotary Borehole Drilling

During mud rotary drilling operations, as the borehole is advanced beyond the conductor casing, the rig geologist/engineer will generally:

- Observe and monitor rig operations
- Conduct all health and safety monitoring and sampling, and supervise health and safety compliance
- Prepare a lithologic log from cuttings, core or soil samples
- Document drilling progress and other appropriate observations on the FADL (Attachment 6.1)

- Supervise the collection and preparation of any soil, soil vapor or groundwater samples

- Supervise any borehole geophysical logging conducted in the wellbore

4.4.2.1 As drilling progresses, the rig geologist/engineer should observe and be in frequent communication with the driller regarding drilling operations. Conditions noted should include relative rates of penetration (as indicated by fast or slow drilling), rotation speeds, chattering and bucking of the rig, lost returns, lost circulation zones, hard or sticky drilling, drilling refusal, etc.. These conditions, including penetration rates, should be recorded on the boring log as per SOP 15.1. Drilling should not be allowed to progress faster than the rig geologist/engineer can adequately observe conditions, compile cuttings logs and supervise safety and sampling activities.

The rig geologist/engineer should also observe the make-up and tightening of connections as additional pipe joints are added to the drill string. Any observed problems and causes, including significant down time, should be recorded on the FADL (Attachment 6.1).

Cutting and fluid containment during drilling should be observed and supervised by the rig geologist/engineer as per specifications in the project work plans. The mud circulation system should be inspected periodically for leaks.

4.4.2.2 The rig geologist/engineer will continue to oversee or conduct appropriate health and safety sampling and monitoring during drilling. If any potentially unsafe conditions are evident from drilling observations or health and safety monitoring, the rig geologist/engineer may suspend drilling operations at any time and take appropriate actions as per the health and safety plan. In the event of a suspension of drilling activities:

- The Site Superintendent must be informed of the situation

- Appropriate corrective action must be implemented before drilling may continue

- The observed problem, suspension and corrective action must be entered on the FADL (Attachment 6.1)

4.4.2.3 During drilling the rig geologist/engineer will compile a boring log as per SOP 15.1. The boring log should include:

- The borehole location with survey and map reference points
- The name of the drilling company and drilling team
- The dates and times of drilling events including when drilling began, the total depth and when it was reached, intermediate milestones (additional casing, geophysical logs etc.) and any changes in equipment (bits, drill pipe, tools etc.)
- Available mud data including volume gains or losses, mud weight, viscosity, yield point and additives
- Relative drilling rate and presence of drill chatter. These parameters may confirm lithologic boundaries
- Lithologic data from cuttings, core or soil samples including depths, frequency and quality
- Intermediate sampling points for core or soil samples
- Premature total depth due to refusal and the cause of refusal
- Any other observed drilling conditions as noted in Section 4.4.2.1

4.4.2.4 The rig geologist/engineer will also enter pertinent drilling information on the FADL (Attachment 6.1). This includes but is not limited to the following:

- The dates and times of drilling events including when drilling began, the total depth and when it was reached, intermediate milestones (additional casing, geophysical logs etc.) and any changes in equipment (bits, drill pipe, tools etc.)
- The dates, times and causes of any significant down time
- Premature total depth due to refusal and the cause of refusal

4.4.2.5 Subsurface soil sampling with a drive sampler can be done at discrete intervals while drilling with mud rotary methods. However, driven samples typically require the removal of the drill pipe to advance the sampler beyond the bit. Depending on the drilled depth and the number of intervals to sample, this may not be efficient. Because the sampler passes through a mud medium, this method is not recommended for sampling soil for analytical parameters. Drive sampling conducted during mud rotary drilling should follow requirements in SOP 3.2. Representative soil vapor and groundwater (grab) samples are also generally not obtained during mud rotary drilling.

4.4.2.6 Borehole geophysical logs may be run at various depths or prior to completing the well. The rig geologist/engineer should note the type(s) of logs run, logging conditions, distribution of log copies and originals, and any observed problems on the FADL (Attachment 6.1).

4.4.3 Borehole Abandonment

If the borehole is to be abandoned once drilling is completed, the abandonment should follow procedures outlined in SOP 8.3. The abandonment will be supervised by the rig geologist/engineer.

4.4.4 Monitoring Well Completion

Mud rotary boreholes can be used for monitoring well installation. However, installation of a monitoring well through drilling mud is difficult and may compromise the integrity of the well. A mud rotary drilled well will also require significantly more time for development. If a monitoring well is to be installed in the borehole, the procedures outlined in SOP 8.1 should be followed. The well installation will be supervised by the rig geologist/engineer.

4.5 Demobilization/Site Restoration

After drilling, sampling, and well installation or borehole abandonment is completed, the drill pipe and tools are laid down, the mast is lowered and the rig is moved off of the location. Demobilization/site restoration will be supervised by the rig geologist/engineer or appropriate designee.

4.5.1 All debris generated by the drilling operation should be removed and appropriately disposed of.

4.5.2 The site should be cleaned, the ground washed as necessary, and the site conditions restored as per the project work plans.

4.5.3 All abandoned borings should be topped off and completed as per the project work plans. All monitoring wells should also have their surface completions finished as per the project work plans.

4.5.4 Any hazards remaining as a result of drilling activities should be identified and appropriate barriers and markers are put in place, as per the site health and safety plan.

4.5.5 All soil cuttings and fluids should be properly contained, clearly labeled and maintained in compliance with the project work plans.

5.0 Records

Records generated as a result of implementation of this SOP will be maintained in the Project Records file in accordance with SQP 4.2.

6.0 Attachments

6.1 Field Activity Daily Log

ATTACHMENT 6.1
FIELD ACTIVITY DAILY LOG

INTERNATIONAL TECHNOLOGY CORPORATION

DAILY LOG	
DATE	
NO.	
SHEET	OF

FIELD ACTIVITY DAILY LOG

PROJECT NAME	PROJECT NO.
FIELD ACTIVITY SUBJECT:	
DESCRIPTION OF DAILY ACTIVITIES AND EVENTS:	
VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS.
WEATHER CONDITIONS:	IMPORTANT TELEPHONE CALLS:
IT PERSONNEL ON SITE:	
SIGNATURE	DATE:

327A-7-94

AIR ROTARY DRILLING

STANDARD OPERATING PROCEDURE

1.0 Purpose

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use during the drilling operations involving air rotary and air rotary casing hammer techniques. Additional specific drilling procedures and requirements will be provided in the project work plans.

2.0 References

2.1 SOP 3.2 - Subsurface Soil Sampling While Drilling

2.2 SOP 6.1 - Sampling Equipment and Well Material Decontamination

2.3 SOP 6.2 - Drilling and Heavy Equipment Decontamination

2.4 SOP 8.1 - Monitoring Well Installation

2.5 SOP 8.3 - Borehole and Well Abandonment

2.6 SOP 10.1 - Soil Organic Vapor Sampling

2.7 SOP 10.2 - Cone Penetration Testing and Hydropunch Groundwater Sampling

2.8 SOP 15.1 - Lithologic Logging

2.9 SQP 4.2 - Records Management

3.0 Definitions

3.1 Air Rotary Drilling

Any method of drilling that employs a rotating drill pipe and bit to advance the borehole and uses air as a circulating medium. Air is forced down through the center of the drill pipe, out through the bit at the bottom of the borehole, and then upward in the annular space between the borehole wall and drill pipe. The upward return stream removes cuttings from the bottom of the borehole.

Air rotary drilling is commonly limited in environmental projects to drilling in hard consolidated rock for coring and installing wells. It may at times be used to drill consolidated sediment or soil. Air rotary drilling achieves some of the fastest penetration rates, compared to other drilling methods, in hard rock terrain.

Air rotary drilling commonly has problems in drilling unconsolidated coarse sediment or soil. The air does not provide sufficient density or viscosity to keep the borehole open while drilling through these deposits and the borehole collapses, binding the bit in the hole. In addition the air circulation is lost through invasion into coarse permeable beds.

Foam additives have been developed to combat these problems but are not allowed by regulatory agencies for use on environmental projects. The air rotary casing hammer drilling method was developed to surmount these problems and is covered below.

A variety of drilling bits may be used to penetrate various formations encountered. Cone type bits and down-hole hammers with button bits are typically used to drill through consolidated rock and granular soils. Drag (fishtail) type bits are commonly used to progress through clayey and silty soils.

Cuttings produced by this method are typically disaggregated making bedding and fabric determination difficult at best. Soil samples can be obtained from the bottom of the hole; however, it typically requires removing the entire drill string.

Additional considerations in using air rotary drilling techniques include the potential of pushing vapor phase contaminants into the surrounding soil/rock matrix and flushing samples, and the possibility of vapors exiting the borehole.

3.2 Air Rotary Casing Hammer Drilling

This drilling method is similar to the air rotary method in that it uses an air rotary drill string (drill pipe and bit) contained inside a slightly larger diameter drive casing. The drive casing is a heavy-walled, threaded pipe that allows for pass-through of the rotary drill bit inside the center of the casing. The drive casing is used to maintain borehole stability, temporarily isolate multiple contaminated zones, and reduce lost circulation of the subsurface air stream.

During drilling the hole is deepened with the air rotary drill string. The drive casing is advanced simultaneously with the air rotary bit, using a rig-mounted hydraulic or air hammer. The drive casing is not rotated.

Air is forced down through the center drill pipe to the bit, and then upward through the space between the drive casing and the drill pipe. The upward return stream removes cuttings from the bottom of the borehole.

This method is highly useful in drilling coarse unconsolidated sediment and soils. Consequently, it is used far more commonly in environmental projects than the air rotary method above. The method is also commonly used to install monitoring wells as there is good depth control, and the drive casing can be progressively pulled as well construction materials are placed in the borehole.

The air rotary casing hammer method is also used to drill through consolidated rock and large boulder beds. For these types of formations a eccentric underreaming bit assembly (such as the ODEX™ or STRATEX™ systems) is attached to the inner rotary drill string. The eccentric underreamer drills a slightly larger diameter borehole than the drive casing. This allows the casing to be advanced while drilling through boulders and bedrock.

Cuttings produced by this method are typically disaggregated, like the air rotary method above. Soil samples can be obtained from the bottom of the hole; however, it typically requires removing the entire inner rotary drill string for each sample run.

4.0 Procedure

This section contains responsibilities, requirements, and procedures for air rotary casing hammer drilling. As stated above, the air rotary casing hammer method more commonly used for environmental projects than just air rotary alone. Consequently, air rotary casing hammer drilling is covered in the remainder of this document. The procedures and requirements for air rotary drilling would essentially be similar to those outlined for the air rotary casing hammer technique.

The selection and implementation of air rotary casing hammer drilling techniques must incorporate site specific conditions and requirements. Consequently, the project work plans will identify the following:

- The purpose of each borehole (e.g., to install monitoring well, soil sampling, soil vapor sampling, etc.)
- Specific methodology for drilling, including equipment to be utilized and cuttings/fluid containment requirements
- Specific locations, depths, and diameters of boreholes
- Type of sampling and/or logging of borehole
- Details of mobilization/demobilization and decontamination of equipment
- Appropriate health and safety guidelines and personnel protective equipment requirements
- Additional procedures or requirements beyond those covered in this SOP

4.1 Responsibilities

4.1.1 The Delivery Order Manager is responsible for ensuring that all air rotary casing hammer drilling activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

4.1.2 The Contractor Quality Control Manager (CQCM) is responsible for periodic review of field generated documentation associated with this SOP. The CQCM is also responsible for the implementation of corrective action (i.e., retaining personnel, additional review of work plans and SOPs, variances to air rotary casing hammer drilling requirements, issuing nonconformances, etc.) if problems occur.

4.1.3 Field personnel assigned to air rotary casing hammer drilling activities are responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff are responsible for reporting deviations from the procedures to the Site Superintendent, Delivery Order Manager, or the CQCM.

4.2 Equipment Requirements and Considerations

4.2.1 Rigs used for air rotary casing hammer drilling shall have the hammer handling system integrally built into the mast assembly. The use of retrofitted drilling rigs without a swing-out, independently operated drive hammer will not be allowed. A rig which requires personnel to climb onto the mast to attach or detach the hammer is unacceptable for safety reasons.

4.2.2 The drill rigs should preferably be self-propelled and capable of accessing anticipated site field conditions. Each rig should have a mechanical draw-works capable of holding roughly 30,000 lbs (minimum) and be equipped with a water injection pump.

4.2.3 The casing hammer shall be a drill-through, pneumatic type with a minimum rated energy force of 7,200 ft.lbs.. The casing hammer will have a rotary drilling rod packing assembly to pressurize the system for an air tight seal, ensuring that all cuttings, water and air are discharged through the hammer exit spout.

4.2.4 The hammer spout will have attached a removable discharge hose of sufficient size and length to reach the cyclone when the hammer is raised to the top of the mast. The hose shall be properly anchored and attached to a cyclone that effectively decelerates cuttings from the air stream.

4.2.5 An air compressor or combination of compressors will be made available and meet minimum discharge requirements at specified pressures. An example discharge/pressure combination for 300 foot borings through interbedded cobble and silt strata is 750 cfm at 250 psi. In-line 0.3 micron filters will be installed in the air stream from the compressor(s) for reducing oil content. The filters will be inspected and changed on a regular basis to prevent the passage of oil into the subsurface.

4.2.6 Drive casings should have a minimum tensile strength of 100,000 psi, and will have external and internal flush threads on each pin and box for connecting. The use of rope thread drive casing with dissimilar metal threaded end pieces attached to mild steel casing bodies will not be allowed. The drive casing shall have uniform wall thickness, tensile strength, and threaded ends machined directly to the casing. A hardened drive shoe with the same internal and external dimensions of the drive casing will be threaded to the bottom of the first joint of the drive casing.

4.2.7 Only Teflon™ based thread compound may be used to lubricate drill pipe and drive casing threads. No other thread compound may be used.

4.2.8 Drive casings of various lengths should be provided by the subcontractor to facilitate emplacement of sand pack, bentonite seal, and grout. One 3-foot, two 5-foot and two 10-foot lengths, besides a sufficient number of standard length drive casing joints, are recommended for each rig.

4.2.9 A hydraulic casing extractor must be used to remove the drive casing from the borehole. Extraction of the casing by "hammering-up" with the casing hammer will not be allowed. The hydraulic casing extractor should have a minimum pulling capacity of 250 tons and be constructed as a single unit with hydraulic cylinders, pulling arms, base plate, valves, hoses, slips and spiders, safety bypass valves, back-up wrench, and break-out tongs. The slips and spiders should be of sufficient size to grip the outside of the drive casing and withstand the lifting force of 250 tons.

4.3 Drilling Site Mobilization

4.3.1 Rig Decontamination and Preparation

4.3.1.1 All drilling and sampling equipment should be decontaminated before drilling as per SOP Nos. 6.2 and 6.1, and the project work plans.

4.3.1.2 The driller and rig geologist/engineer should inspect the drilling equipment for proper maintenance and appropriate decontamination prior to each time the rig is mobilized to a site. All clutches, brakes and drive heads should be in proper working order. All cables and hoses should be in good condition. All drill pipe, drive casing and bits should also be in good condition (e.g., no damaged threads on the drive casing or drill pipe, no damaged or excessively worn bits, etc.).

4.3.1.3 Any observed leakage of fluids from the rig should be immediately repaired and the rig decontaminated again before it is allowed to mobilize.

4.3.2 Site Preparation

4.3.2.1 The logistics of drilling, logging, sampling, cuttings/fluid containment, and/or well construction should be determined before mobilizing. The site should be prepared as per the project work plans.

4.3.2.2 Before mobilization, the Site Superintendent and/or the rig geologist/engineer should assess the drilling site with the driller. Drill site space requirements commonly include not only area for the rig, but also swing-out clearance for the cyclone and access for a pipe truck or fork lift carrying pipe. This assessment should identify potential hazards (slip/trip/fall, overhead power lines, etc.), and determine how drilling operations may impact the environment (dust, debris, noise). Potential hazards should be evaluated and corrected, or the borehole location changed or shifted, as per the project work plans.

4.3.2.3 The Site Supervisor or appropriate designee should ensure that all identifiable underground utilities around the drilling location have been marked, and the borehole location appropriately cleared per the project work plans. At a minimum, copies of the site clearance documents should be kept on-site.

4.3.3 Mobilization and Set-Up

4.3.3.1 Once the site is prepared, the rig is mobilized to the site and located over the borehole location. The rig is leveled with a set of hydraulic pads attached to the front and rear of the rig. The driller should always raise the mast slowly and carefully to prevent tipping or damaging the rig, and avoiding obstructions or hazards. The cyclone should be positioned so that cuttings can be easily collected as they drop out of the bottom opening.

4.3.3.2 Appropriate barriers and markers should be in place prior to drilling, as per the site health and safety plan. Visqueen (plastic) may be required beneath the rig per the project work plans.

4.3.2.3 Appropriate cuttings and other investigation-derived waste containment should be set on site prior to commencement of drilling. If drilling is to be conducted in the saturated zone, provisions should be made to ensure adequate containment of formation water produced during drilling operations.

4.3.4 Health and Safety Requirements

4.3.4.1 Tailgate Safety Meetings should be held in the manner and frequency stated in the health and safety plan. All IT and subcontractor personnel at the site should have appropriate training and qualifications as per the health and safety plan.

4.3.4.2 During drilling all personnel within the exclusion zone should pay close attention to rig operations. The drill pipe and drive casing are quite heavy, and dangerous if dropped. Other equipment on the rig can easily snag clothing and crush fingers or limbs. In addition, heavy equipment such as pipe trucks and fork lifts will be operated at the drill site.

4.3.4.3 The casing hammer is quite noisy when the drive casing is being advanced. In addition, the rig can generate considerable noise when drilling through gravel and cobbles. Therefore, establishing clear communication signals with the drilling crew is mandatory since verbal signals may not be heard during the drilling process. The entire crew should be made aware to inform the rig geologist/engineer of any unforeseen hazard, or when anyone is approaching the exclusion zone.

4.4 Drilling Procedures

4.4.1 Breaking Ground

4.3.1.1 Prior to the commencement of drilling, all safety sampling and monitoring equipment will be appropriately calibrated per the project work plans.

4.4.1.2 The rig geologist/engineer should inform the driller of the appropriate equipment (e.g., cookie cutter,etc.) to be used for penetration of the surface cover (e.g., asphalt, concrete, cement, etc.). In the event of breaking ground where a shallow subsurface hazard may exist (unidentifiable utility, trapped vapors, etc.), the driller should be informed of the potential hazard. Drilling should commence slowly to allow continuous visual inspection and/or monitoring, and if necessary, stop for probing or hand excavation and clearance.

4.4.2 Borehole Drilling

During drilling operations, and as the borehole is advanced, the rig geologist/engineer will generally:

- Observe and monitor rig operations;
- Conduct all health and safety monitoring and sampling, and supervise health and safety compliance;
- Prepare a lithologic log from soil samples or cuttings; and
- Supervise the collection of, and prepare soil, soil vapor, and groundwater samples.

4.4.2.1 As drilling progresses the rig geologist/engineer will be in frequent communication with the driller and be cognizant of drilling conditions which may provide lithologic or chemical information. This includes relative rates of penetration (indicative of fast or slow drilling) and chattering or bucking of the rig. These conditions should be recorded on the boring log per SOP No, 15.1.

The rig geologist/engineer should know the total depth of the borehole at all times during drilling. Drilling should not be allowed to progress faster than the rig geologist/engineer can adequately observe conditions, compile boring logs, and supervise sampling and safety activities.

The rig geologist/engineer should also observe the rig operations, including the make-up and tightening of connections as additional drill pipe and drive casing are added to the drill string. No leaks should be evident in the air system on the rig. This includes the drill pipe extending from the top head drive through the casing hammer. Any observed problems, including significant down time, and their causes are recorded on the Field Activity Daily Log (FADL) (Attachment 6.1).

4.4.2.2 Cuttings and fluids containment during drilling should be observed and supervised by the rig geologist/engineer, as per specifications in the project work plans.

4.4.2.3 The rig geologist/engineer will oversee or conduct appropriate health and safety sampling and monitoring. If any potentially unsafe conditions are evident from the above drilling observations and the health and safety sampling and monitoring, the rig geologist/engineer may suspend drilling operations at any time and take appropriate actions as per the health and safety plan. In the event suspension of drilling activities occur:

- The Site Superintendent must be informed of the situation;
- Appropriate corrective action must be implemented before drilling may be continued; and
- The observed problem, suspension, and corrective action are entered on the FADL.

4.4.2.4 In some instances water may need to be added to the air stream to circulate cuttings to the surface. This should be done only if absolutely necessary, following specifications for the water source and/or any sampling and analysis requirements per the project work plans. Foam additives should not be used and are commonly prohibited by regulatory agencies for environmental applications. If water is injected into the borehole it should be noted on the boring log and the FADL.

4.4.2.5 During drilling the rig geologist/engineer will compile a boring log as per SOP No. 15.1. The log will be compiled preferably from soil samples recovered while drilling. Logs should only be compiled solely from cuttings if this is the only available option. The cuttings are obtained by a fine mesh basket or other appropriate container held under the bottom opening of the cyclone.

Observations of drilling conditions and responses are also entered on the log as discussed above and in SOP No. 15.1. If total depth was reached prematurely due to refusal, the cause of refusal should be noted on the boring log and the FADL.

4.4.2.6 Subsurface soil samples may be collected with a split spoon sampler or Shelby tube during drilling per SOP No. 3.2. This will require tripping out (removing) the inner rotary drill string. The sampling will be supervised by the rig geologist/engineer. Soil samples (drive samples) can be readily obtained at discrete intervals with these methods.

4.4.2.7 Soil organic vapor (SOV) sampling may be conducted at discrete intervals during air rotary casing hammer drilling. This is done by stopping at the desired depth, tripping out the inner rotary drill string, and driving a sample probe through the drive casing into the soil ahead of the drive shoe. The vapor sample is then collected through the sample probe using a vacuum pump at the surface. The sampling should be supervised by the rig geologist/engineer following procedures in SOP No. 10.1.

4.4.2.8 Groundwater screening (grab) samples can be obtained at discrete intervals during drilling. One method is to drill to the bottom of the selected interval or zone and pull the drive casing back a selected distance, allowing groundwater through the open borehole. The inner rotary drill string is tripped out of the hole and a water sample is then collected with a bailer run through the inside of the drive casing.

Another method is to stop the drill string at a selected interval or zone, trip out the inner rotary drill string, and advance a hydropunch sampler beyond the drive casing to retrieve a water sample. The groundwater screening sampling procedures should essentially follow those described in SOP No. 10.2.

4.4.3 Borehole Abandonment

If the borehole is to be abandoned once drilling is completed, the abandonment will follow procedures outlined in SOP No. 8.3. The abandonment will be supervised by the rig geologist/engineer.

4.4.4 Monitoring Well Completion

If a monitoring well is to be installed in the borehole, the well completion will follow procedures outlined in SOP No. 8.1. The well installation activities will be supervised by the rig geologist/engineer.

4.5 Demobilization/Site Restoration

After drilling, sampling, well installation, or borehole abandonment is completed the air rotary casing hammer rig is rigged down and removed from the borehole location. The demobilization/site restoration will be supervised by the rig geologist/engineer or appropriate designee.

4.5.1 All debris generated by the drilling operation will be removed and appropriately disposed.

4.5.2 The site should be cleaned (ground washed if necessary) and surface conditions restored as per the project work plans.

4.5.3 All abandoned borings should be topped off and completed as per the project work plans. All monitoring wells will also have their surface completions finished as per the project work plans.

4.5.4 Any remaining hazards as a result of drilling activities will be identified and appropriate barriers and markers put in place, as per the health and safety plan.

4.5.5 All soil cuttings and fluids will be properly contained, clearly labeled, and maintained as per the project work plans.

4.5.6 The Site Superintendent or appropriate designee should inspect the site to make sure that post-drilling site conditions are in compliance with the project work plans.

5.0 Records

Records generated as a result of implementation of this SOP will be maintained in the Project Records file in accordance with SQP No. 4.2.

6.0 Attachments

6.1 Field Activity Daily Log

ATTACHMENT 6.1

FIELD ACTIVITY DAILY LOG

INTERNATIONAL TECHNOLOGY CORPORATION

FIELD ACTIVITY DAILY LOG

DAILY LOG			
DATE			
NO.			
SHEET		OF	

PROJECT NAME	PROJECT NO.
FIELD ACTIVITY SUBJECT:	
DESCRIPTION OF DAILY ACTIVITIES AND EVENTS:	
VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS.
WEATHER CONDITIONS:	IMPORTANT TELEPHONE CALLS:
IT PERSONNEL ON SITE:	
SIGNATURE	DATE:

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Orders 005 and 011

Prepared for

DEPARTMENT OF THE NAVY
David DeMars
Lead Remedial Project Manager
Southwest Division
Naval Facilities Engineering Command
San Diego, California

FINAL QUALITY ASSURANCE PROJECT PLAN FOR PHASE I GROUNDWATER DATA GAPS INVESTIGATION

HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

DS.0011.14744

July 31, 2000

Prepared by

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Doug Bielskis, Project Manager

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REVIEW AND APPROVALS

TtEMI Program Quality Assurance Manager:	Gregory Swanson TtEMI San Diego	Date: 7. 17. 06
Navy Quality Assurance Officer:	Narciso Ancog	Date: 7/25/06

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CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

TABLES

FIGURES

ABBREVIATIONS AND ACRONYMS

ARAR	Applicable or relevant and appropriate requirement
AST	Aboveground storage tank
AWQC	Ambient water quality criteria
BEC	BRAC Environmental Coordinator
bgs	Below ground surface
BHC	Benzene hexachloride
BRAC	Base Realignment and Closure
CAP	Corrective action plan
CARF	Contaminant-adjusted removal factor
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract laboratory program
COPC	Chemical of potential concern
CPR	Cardiopulmonary resuscitation
CQI	Continuous quality improvement
CRDL	Contract-required detection limit
CRQL	Contract-required quantitation limit
CTO	Contract task order
4,4’-DDE	Dichlorodiphenyltrichloroethene
4,4’-DDT	Dichlorodiphenyltrichloroethane
DHS	California Department of Health Services
DNAPL	Dense nonaqueous-phase liquid
DOT	U.S. Department of Transportation
DQO	Data quality objective
EDD	Electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
EWI	Environmental work instruction
FE2+	Iron (II)
FE3+	Iron (III)
FS	Feasibility study
FSP	Field sampling plan
GC	Gas chromatograph
GDGI	Groundwater data gaps investigation
GIS	Geographic information system

ABBREVIATIONS AND ACRONYMS (Continued)

HGAL	Hunters Point Shipyard groundwater ambient level
HPAL	Hunters Point Shipyard ambient level
HPS	Hunters Point Shipyard
HSM	Health and safety manager
HSP	Health and safety plan
IC	Installation coordinator
ICP	Inductively coupled plasma
ID	Identification
IDL	Instrument detection limit
IDW	Investigation-derived waste
IR	Installation Restoration
LCS	Laboratory control sample
LIMS	Laboratory information management system
µg/L	Micrograms per liter
MDL	Method detection limit
mL	Milliliter
MS	Matrix spike
MSD	Matrix spike duplicate
NAWQC	National Ambient Water Quality Criteria
NEDTS	Navy Environmental Data Transfer Standard
NFESC	Naval Facilities Engineering Service Center
NRDL	Naval Radiological Defense Laboratory
ORC	Oxygen release compound
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear aromatic hydrocarbon
PARCC	Precision, accuracy, representativeness, completeness, and comparability
PCB	Polychlorinated biphenyl
PE	Performance evaluation
PM	Project manager
POC	Point of compliance
PPE	Personal protective equipment
PRC	PRC Environmental Management, Inc.
PVC	Polyvinyl chloride
QA	Quality assurance
QAO	Quality assurance officer
QAPP	Quality assurance project plan

ABBREVIATIONS AND ACRONYMS (Continued)

QC	Quality control
QCC	Quality control coordinator
QCSR	Quality control summary report
RAMP	Remedial action monitoring plan
RG	Registered Geologist
RI	Remedial investigation
ROD	Record of decision
RPD	Relative percent difference
RPM	Remedial project manager
RU	Remedial unit
RWQCB	Regional Water Quality Control Board
SAP	Sampling and analysis plan
SDG	Sample delivery group
SOP	Standard operating procedure
SOW	Scope of work
SQL	Sample quantitation limit
SVOC	Semivolatile organic compound
SWDIV	Naval Facilities Engineering Command, Southwest Division
TBD	To be determined
TCE	Trichloroethene
TDS	Total dissolved solids
TIC	Tentatively identified compound
TIZ	Tidally influenced zone
TPH	Total petroleum hydrocarbons
TPH-d	Total petroleum hydrocarbons as diesel
TPH-g	Total petroleum hydrocarbons as gasoline
TPH-mo	Total petroleum hydrocarbons as motor oil
TtEMI	Tetra Tech EM Inc.
UST	Underground storage tank
VOC	Volatile organic compound

A1 INTRODUCTION

Tetra Tech EM Inc. (TtEMI) received Contract Task Orders (CTO) 005 and 011 under Comprehensive Long-term Environmental Action Navy Contract No. N62474-94-D-7609 (CLEAN II) from the Department of the Navy, Naval Facilities Engineering Command, Southwest Division (SWDIV) to conduct remedial investigation (RI) through record-of-decision activities at Parcels D and E (CTO 005) and Parcels B and C (CTO 011) at Hunters Point Shipyard (HPS) in San Francisco, California. TtEMI received subsequent modifications to CTOs 005 and 011 to evaluate groundwater data gaps. Development of the scope of work (SOW) for the groundwater data gaps investigation (GDGI) was based on agency input provided during a series of working meetings in February and March 2000 (SWDIV 2000a, 2000b, 2000c, 2000d), as detailed in the field sampling plan (FSP) that accompanies this document.

This quality assurance project plan (QAPP) documents policies, project organization, and quality assurance and quality control (QA/QC) procedures to be implemented for the Phase I GDGI at HPS Parcels B, C, D, and E. The Phase I GDGI is focused on Parcels C and D; however, additional investigation areas within Parcels B and E are included in the Phase I GDGI to assess basewide groundwater flow patterns and to aid in the delineation of investigation areas at parcel boundaries (specifically Installation Restoration [IR] Site 25 in Parcel C). Additional work may be required at Parcels B, C, D, and E in subsequent phases of the GDGI. In particular, the Phase II GDGI will include a second round of sampling, as necessary, at the locations specified in the accompanying FSP. The QAPP, and the accompanying FSP, will be amended to be applicable to the subsequent phases of the GDGI.

The QAPP also fully describes the project data quality objectives (DQO), which have been developed through the seven-step DQO process (U.S. Environmental Protection Agency [EPA] 1994d), in accordance with EPA guidance for preparation of QAPPs (EPA 1998). The final QAPP incorporates revisions made based on regulatory agency comments on the draft version of the QAPP dated June 1, 2000. Table A-1 summarizes these modifications. Section A1.1 describes the format of the plan. Section A1.2 describes the proposed use of this QAPP, and Section A1.3 provides background information about the groundwater investigation. Section A1.4 describes the seven-step process by which the DQOs for this project were defined. Tables are presented where they are first cited in the text, while figures follow the text and the references. This QAPP and the accompanying FSP form the sampling and analysis plan (SAP); field crews are expected to have both the QAPP and the FSP on hand at all times, and both documents are included in the same binder for easy reference.

A summary of the site background and the results of previous investigations is presented in this QAPP, while a more detailed background and an analysis of site information are presented in the RI reports (PRC Environmental Management, Inc. [PRC] 1996a, 1997a, 1996b, and 1997b, respectively) and the feasibility study (FS) reports (PRC 1996c; TtEMI 1998a; PRC 1997c; and TtEMI 1998b, respectively) for Parcels B, C, D, and E. All field activities in support of the Phase I GDGI data collection and measurement activities will be conducted in accordance with TtEMI's "CLEAN II Program Health and Safety Plan (HSP), Revision I" (PRC 1995) and the basewide HSP (PRC 1996d).

TABLE A-1

REVISIONS TO DRAFT QUALITY ASSURANCE PROJECT PLAN

Section	Modification
A1	• Clarified the purpose and objective of the Phase I GDGI • Specified that the existing SAP will be amended to apply to subsequent phases of the GDGI
A1.4.3, Table A-3	• Revised to reflect the current number of wells for resampling, water level measurements, and land survey
A1.4.7, Table A-3	• Revised Step 7 to indicate that wells needed for the sampling program will be repaired, redeveloped, or replaced as necessary based on results of well inspection.
A5.3	• Revised to include additional text regarding performance evaluation samples
A5.5.1	• Revised to specify a quality control limit of 25 percent relative percent difference (RPD) for field duplicates, and to refer to Appendix 3 for quality control limits for matrix spike and matrix spike duplicate samples.
E1	• Revised references to include minutes from working meetings
Figure A-2 (final)	• New Figure A-2 includes both new and old groundwater remedial units for Parcels C and D
Figure A-2 (draft)	• Revised as Figure A-3 to include Navy Base Realignment and Closure (BRAC) Environmental Coordinator, TtEMI sample tracking coordinator, TtEMI health and safety and QA on-site personnel, and subcontractor laboratories
Appendix 1	• Replaced existing well sampling sheet with sheet from TtEMI standard operating procedure No. 15.
Appendix 2, Table 2-1	• Revised to include information for salinity, methane, ethane, and ethene analyses
Appendix 2, Table 2-2	• Revised lower reporting limit for 1,1,2,2-tetrachloroethane to 1.0 microgram per liter

A1.1 DOCUMENT REQUIREMENTS AND FORMAT

The format of this QAPP conforms to "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations," EPA QA/R-5 (EPA 1999c) and "Guidance for the Data Quality Objectives Process," EPA QA/G-4 (EPA 1994d). EPA QA/R-5 states that the requirements for QAPPs include (1) evaluating the DQOs for the project, (2) ensuring that intended measurements and data acquisitions are appropriate, (3) ensuring that QA/QC procedures are adequate to confirm data quality, and (4) identifying limitations on the use of the data. Table A-2 provides a summary of the elements of this QAPP.

A1.2 USE OF THE DOCUMENT

Each element of the QAPP is discussed in this document as it pertains to the Phase I GDGI. The QAPP provides specific guidance and QA/QC criteria for collecting, evaluating, and submitting data while completing the project. To ensure the quality and usability of the data collected, all personnel working on the project are required to read and comply with the procedures set forth in this document.

A1.3 BACKGROUND

Background information about HPS and the GDGI, as well as a general site conceptual model for groundwater investigations at HPS, are presented in the following subsections. Summarized site-specific background information and analytical results are presented in Section A3. Detailed background information, such as information about site-specific operational histories, environmental restoration activities, and the results of environmental investigation and analysis, is presented in the Parcels B, C, D, and E RI reports (PRC 1996a, 1997a, 1996b, and 1997b, respectively).

A1.3.1 Facility Location

HPS is located in southeast San Francisco on a promontory that extends east into San Francisco Bay (Figure A-1). The HPS facility consists of five contiguous geographic parcels (A through E) making up approximately 493 acres, and a sixth parcel, the offshore area (Parcel F), which is approximately 443 acres in size. Parcel B occupies approximately 63 acres of shoreline and lowland coast in the northeastern portion of HPS. Parcel C consists of approximately 79 acres of shoreline and lowland

TABLE A-2

QUALITY ASSURANCE PROJECT PLAN ELEMENTS

QAPP Element	EPA QAPP[1] Section Number	This QAPP Section Number
A. Project Management		
Title and approval sheet	A1	Report cover
Table of contents	A2	Page i
Distribution list	A3	Cover letter
Project/task organization	A4	A2
Problem definition/background	A5	A1, A3
Project/task description	A6	A4
Quality objectives and criteria for data measurement	A7	A5
Special training/certification	A8	A2.3
Documentation and records	A9	A6
B. Measurement/Data Acquisition		
Sampling process design (experimental design)	B1	B2
Sampling methods	B2	B3
Sample handling and custody	B3	B4
Analytical methods	B4	B5
Quality control	B5	B6
Instrument/equipment testing, inspection, and maintenance	B6	B7
Instrument/equipment calibration and frequency	B7	B7, B8
Inspection/acceptance of supplies and consumables	B8	B8
Nondirect measurements	B9	B9
Data management	B10	B9.3
C. Assessment/Oversight		
Assessments and response actions	C1	C1
Reports to management	C2	C1.3
D. Data Validation and Usability		
Data review, verification, and validation	D1	D1.1
Verification and validation methods	D2	D1.2
Reconciliation with user requirements	D3	D2

Note:

1 EPA 1999c

coast along the east-central portion of HPS. Parcel D occupies approximately 128 acres of southeast-central shoreline and lowland coast. Parcel E consists of approximately 135 acres of shoreline and lowland coast in the southern portion of HPS.

A1.3.2 Facility Background

HPS operated as a commercial dry dock facility from 1869 until December 29, 1939, when the Navy purchased the property. From 1945 until 1974, the Navy built ships and modified, maintained, and repaired submarines at HPS. In 1974, the Navy ceased shipyard operations at HPS, placed the facility in industrial reserve, and transferred control of the property to its Office of the Supervisor of Shipbuilding, Conversion, and Repair in San Francisco. From May 1976 to June 1986, Triple A Machine Shop leased most of HPS from the Navy and operated a commercial ship repair facility.

A1.3.3 Phase I Groundwater Data Gaps Investigation

The Phase I GDGI consists of four discrete tasks, as described further in the accompanying FSP: (1) assess the condition of all existing wells, (2) measure basewide water levels to determine the pieziometric surface at existing A- and B-aquifer wells, (3) perform additional characterization of the B-aquifer in Parcels C and D by sampling existing and newly installed wells for hydrogeologic and chemical parameters, and (4) resample existing A-aquifer and water-bearing zone wells in Parcels C and D for chemical parameters to confirm the extent of existing groundwater remedial units (RU). Task 1 was completed on April 4, 2000, and is described in the accompanying FSP. Basewide water levels (Task 2) were measured on July 12, 2000, and survey measurements associated with Task 2 were initiated on July 19, 2000. This QAPP describes tasks 2 though 4.

The Phase I GDGI is intended to assist in the beneficial use evaluation of groundwater at Parcels C and D. The draft final FS reports for Parcels C and D (TtEMI 1998a; PRC 1997c) evaluated risks to human health (by the inhalation pathway) and to aquatic ecological receptors posed by groundwater; however, the FS reports did not evaluate the beneficial use of groundwater at HPS since the Navy did not consider drinking water standards applicable or relevant and appropriate requirements (ARAR). A beneficial use evaluation for Parcels C and D was undertaken in response to subsequent comments from the regulatory agencies.

In response to agency comments received on the beneficial use evaluation, the Navy conducted a series of working meetings with the regulatory agencies and other stakeholders to evaluate historical groundwater data at Parcels C and D that exceeded drinking water standards (that is, the most stringent federal or state primary maximum contaminant levels [MCL]). During the working meetings, conducted on February 7, March 7, March 16, and March 23, 2000, several recommendations were made that additional sampling or evaluation be conducted. In particular, the Navy developed revised groundwater RUs, based on groundwater monitoring wells with historic concentrations that exceeded drinking water standards or ambient groundwater levels, and proposed these areas for further evaluation (Figure A-2). Based on the recommendations made during the working meetings, the Navy developed the scope of work for the Phase I GDGI, as presented in this QAPP and accompanying FSP. The minutes from the working meetings, as well as the data summary tables used during the working meetings, are included in Appendix A of the FSP.

A1.4 DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements developed through the seven-step DQO process (EPA 1994d, 1999b). The primary outputs of that iterative methodology are definition of the problem under investigation (Step 1); identification of the decisions that require inputs and resolution (Step 2); identification of those inputs (Step 3); delineation of the study boundaries (Step 4); development of decision rules (Step 5); specification of tolerable limits on errors (Step 6); and optimization of the sampling design (Step 7). The seven-step DQO process for this project is presented in Sections A1.4.1 through A1.4.7; a summary of the DQO steps and related components is presented in Table A-3. The seven-step DQO process set forth in this QAPP addresses the four tenets of the study respective to the Phase I GDGI. Task 1, the assessment of the condition of all wells completed in April 2000 and Task 2, basewide water level measurements on July 12, 2000, are discussed in this section.

TABLE A-3

IDENTIFICATION OF THE SEVEN STEPS OF THE DATA QUALITY OBJECTIVES PROCESS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Decision(s)**	**Identify Inputs to the Decision(s)**	**Define Study Boundaries**	**Develop Decision Rules**	**Specify Tolerable Limits on Error**	**Optimize Sampling Design**
I: Most monitoring wells at HPS have not been sampled in more than 4 years, and their conditions are unknown.	Which monitoring wells are in a condition that requires repair or redevelopment prior to sample collection or water level measurement? Which monitoring wells are in a condition that requires decommissioning and replacement prior to sample collection or water level measurement?	Comprehensive survey of condition of all existing monitoring wells. Survey includes measuring the total depth of the well to assess silt buildup, measuring the depth to water to compare to historical levels, measuring product thickness to compare to historical levels, and a visual inspection of the general integrity of the well.	Spatial boundaries of well condition survey are all existing monitoring wells at HPS. The temporal boundary of the well condition survey is 4 weeks.	• If a monitoring well has minor damage (for example, damaged surface casing), then repairs to such damage will be made. • If a monitoring well has significant damage (for example, damaged well casing) that is beyond repair, then the well will be decommissioned. If the well location is deemed necessary for future monitoring, then the well will be replaced. • If there is visual evidence of surface contamination entering the well casing, then the well will be redeveloped, decommissioned, replaced, or reassessed, as appropriate. • If a monitoring well is not damaged and does not show signs of surface contamination entering the well casing, then no action will be taken prior to sample collection. • If well sediment covers less than 10 percent of the well screen interval, then no redevelopment is necessary. • If well sediment covers 10 to 50 percent of the well screen interval, then the well will be redeveloped. • If well sediment covers more than 50 percent (or 3 feet, whichever is greater) of the well screen interval, then the well will be decommissioned. The well will be replaced if the location is deemed necessary for future monitoring.	Judgmental sampling is being utilized; therefore, a statistical model is not appropriate. Measurement quality objectives in the form of precision and accuracy goals are designed to minimize analytical errors.	Each well will be photographed for documentation purposes. Selection of sampling and measurement locations selected in basewide groundwater sampling plan will be biased to wells that do not require repair, redevelopment, or replacement, as possible without compromising the objectives of the Phase I GDGI. Wells that are needed for the sampling program will be repaired, redeveloped, or replaced as necessary. Efforts to repair, redevelop, or replace existing wells will be conducted first at wells selected for sampling and measurement in the FSP.
II: The most current A-aquifer and potentiometric surface map was generated more than 4 years ago and may not reflect current groundwater flow conditions. Recharge and discharge from utility lines may be affecting groundwater flow. Potential ground settling may affect current groundwater elevation measurements.	What is the current potentiometric surface of the A-aquifer (particularly in the vicinity of existing groundwater RUs)?	Water level measurements from approximately 187 existing A-aquifer locations, to be collected using a sounder. Evaluate water level measurement data and interpret the potentiometric surface using (1) an appropriate numeric interpolation technique and (2) modification by a California Registered Geologist. Survey measurements for the tops of well casings at 24 existing well locations as control points for comparison to existing survey data. In addition, approximately 65 wells with incomplete survey data will be surveyed.	The areal limits of the water level measurement study area consist of A-aquifer wells previously sampled at HPS. The areal limits of the survey measurements are the boundaries of the facility. The vertical limit of the water level measurement study area is the depth of the A-aquifer wells installed at HPS. The vertical limit of the survey measurements is the ground surface or the top of the casing, whichever is appropriate. The temporal limit of a single water level measurement event is a period that will begin 1 hour before a high or low tide and will not extend beyond 3 hours after the same high or low tide. The temporal limit of the Phase I water level measurement study is 2 weeks (during which the wells will be sampled once). A Phase II event will also be conducted to account for seasonal variations. The temporal limit of the survey study is 1 week.	• If the interpreted potentiometric surface at a given parcel predicts different flow directions when compared with historical data collected during the same season and at the same location, then the data may be further evaluated, depending on whether groundwater contamination is present, to identify the cause of the inconsistency. • If the interpreted potentiometric surface at a given parcel predicts different flow directions when compared with historical data collected in the same season and at the same location and groundwater flow potentially affects RUs, then an evaluation of potential flow impacts from utility lines will be conducted and utility lines will be repaired, if necessary, and new water level measurements will be collected. • If the interpreted potentiometric surface at a given parcel predicts different flow directions when compared with historical data collected in the same season and at the same location and groundwater flow in the area potentially affects RUs, and the data were not collected near utility lines, then (1) pressure transducers may be installed to confirm the data or (2) the data will be used to create an updated potentiometric surface map. • If the interpreted potentiometric surface at a given parcel does not predict different flow directions (compared to historical data collected in the same season and at the same location), then no action will be taken. • If the survey data at more than 30 percent of the resurveyed wells vary by more than 0.05 foot when compared with historical elevation data, then an additional 20 wells will be resurveyed before the groundwater elevation measurements are taken (additional survey data will be evaluated using same decision rule). • If the survey data at more than 30 percent of the resurveyed wells do not vary by more than 0.05 foot when compared with historical elevation data, then no action will be taken.	Judgmental sampling is being utilized; therefore, a statistical model is not appropriate. Measurement quality objectives in the form of precision and accuracy goals are designed to minimize analytical errors.	Well locations are selected to provide general coverage across HPS, with a focus on individual remedial RUs. Additional wells may be installed to assess potentiometric surface, as appropriate. The water level measurement period will be during relatively low tidal fluctuation in San Francisco Bay. The lowest fluctuation period during a 28-day lunar cycle is best, but may not be convenient because the high and low tides may occur during darkness. A low fluctuation period that allows groundwater measurement during daylight hours will be selected. The sampling design is described in further detail in the FSP. .

TABLE A-3 (Continued)

IDENTIFICATION OF THE SEVEN STEPS OF THE DATA QUALITY OBJECTIVES PROCESS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Decision(s)**	**Identify Inputs to the Decision(s)**	**Define Study Boundaries**	**Develop Decision Rules**	**Specify Tolerable Limits on Error**	**Optimize Sampling Design**
III: The extent of contamination in the B-aquifer and its relationship to the A-aquifer at Parcels C and D (and, potentially, at a part of Parcel B) have not been evaluated because chemical and hydrogeologic data are insufficient to support an evaluation. Furthermore, TDS and yield data are insufficient to evaluate if cleanup to drinking water standards is necessary.	What is the nature and extent of contamination in the B-aquifer in (1) areas where Bay Mud does not separate the A- and B-aquifers, and (2) areas where the overlying A-aquifer is impacted by VOCs? What are the hydrogeologic conditions of the B-aquifer, (particularly in the vicinity of existing A-aquifer groundwater RUs)? Do TDS and yield values in the B-aquifer meet the state and/or federal criteria for exemption from potential use as a drinking water source?	Samples collected from six existing B-aquifer wells (including two nested A- and B-aquifer well pairs) and about 20 new nested A- and B-aquifer well pairs will be analyzed for vertical gradient, yield, TDS, chemical concentrations, porosity, permeability, and geologic characteristics. Validated chemical data (with detection limits below the relevant ARARs) for COPCs in groundwater will be collected from existing and new B-aquifer wells. Chemical data will be mapped in plane view and cross section and input into the GIS database to establish the extent of B-aquifer contamination. Groundwater elevation data from 18 existing B-aquifer wells (in Parcels C and E) and about 20 new B-aquifer wells (in Parcels B, C, and D) will be used to assess the magnitude and direction of the horizontal gradient of the B-aquifer.	The areal limits of the B-aquifer study area are the boundaries of Parcels B, C, D and E. The vertical limit of the B-aquifer study area is a depth of 5 feet below the bottom of the B-aquifer or to the bottom of VOC contamination, whichever is less. The temporal limit of the B-aquifer study is 1 month (in which the wells will be installed and sampled once). A Phase II aquifer study will be conducted to account for seasonal variations.	• Evaluate chemical and hydrogeologic data to assess the nature and extent of B-aquifer contamination. If data indicate that A-aquifer contamination has migrated to the B-aquifer and is not adequately characterized, then additional sampling locations will be proposed for Phase II sampling to characterize the extent of the plume. • If a B-aquifer area does not contain chemicals at concentrations that exceed the most stringent primary MCL or HGAL (or NAWQC, as applicable), then the area will not be evaluated in the FS. • Evaluate TDS and yield data from the B-aquifer and compare to state and federal exemption criteria for drinking water sources. If a B-aquifer area contains chemicals at concentrations that exceed the most stringent primary MCL or HGAL but the area meets the state and federal exemption criteria, then ecological risk and human health risk via the inhalation exposure pathway will be evaluated and areas that result in risks through these pathways will be evaluated in the FS. • If a B-aquifer area contains chemicals at concentrations that exceed the most stringent primary MCL or HGAL and the area does not meet the state and federal exemption criteria, then the area will be evaluated in the FS. Note: If a B-aquifer area that meets the above criteria is part of a chemical plume that exceeds the most stringent primary MCL or HGAL, then the entire plume will be evaluated in the FS regardless of the state and federal exemption criteria.	Judgmental sampling is being utilized; therefore, a statistical model is not appropriate. Measurement quality objectives in the form of precision and accuracy goals are designed to minimize analytical errors.	New nested A- and B-aquifer well pair locations will be selected using the following guidelines: • Wells will be placed near areas of known A-aquifer contamination (as discussed in the working meetings in February and March 2000). • Wells will be placed to define potential contaminant migration in areas where Bay Mud does not separate the A- and B-aquifers. • If groundwater flow direction in either the A- or B-aquifer can be estimated, wells will be placed downgradient of known contamination.

TABLE A-3 (Continued)

IDENTIFICATION OF THE SEVEN STEPS OF THE DATA QUALITY OBJECTIVES PROCESS
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Decision(s)**	**Identify Inputs to the Decision(s)**	**Define Study Boundaries**	**Develop Decision Rules**	**Specify Tolerable Limits on Error**	**Optimize Sampling Design**
IV: Existing A-aquifer and bedrock water-bearing zone ecological and human health RUs were developed on the basis of chemical data collected more than 4 years ago.	Are the RUs representative of current conditions at the site?	Validated chemical data (with detection limits below the relevant ARARs) for COPCs in groundwater will be collected from the existing 68 A-aquifer and 14 bedrock water-bearing zone wells, as detailed in the FSP.	The areal limits of the A-aquifer and bedrock water-bearing zone study area are the boundaries of Parcels B, C, and D. The vertical limit of the A-aquifer and bedrock water-bearing zone study area is the thickness of the A-aquifer and the depth of the bedrock water-bearing zone wells installed within the boundaries of Parcels B, C, and D. The temporal limit of the A-aquifer and bedrock water-bearing zone study is 2 weeks (in which the wells will be sampled once). A Phase II study will be conducted to account for seasonal variations.	Chemical data will be used to revise the boundaries of the existing RUs. Revisions will be made based on the following decision rules: • If the results for both sampling rounds at a well are below the MCLs or NAWQCs, then the boundaries of the existing RU will be revised (reduced) to reflect this change. • If the results for one or both sampling rounds at a well are not below the MCLs or NAWQCs, then the well will be retained in the RU; however, the boundary may be adjusted to reflect any changes. • If concentrations indicate that a plume has migrated, then additional sampling locations will be proposed for Phase II sampling to characterize the extent of the plume.	Judgmental sampling is being utilized; therefore, a statistical model is not appropriate. Measurement quality objectives in the form of precision and accuracy goals are designed to minimize analytical errors.	Additional parameters may be collected to support remedial decisions, and to evaluate technologies in the feasibility study. The following criteria will be used to select wells for additional sampling: • Wells within previously identified RUs (based on ecological risk and human health risk via the inhalation exposure pathway) will be selected for resampling. • Certain wells surrounding previously identified RUs will be selected for resampling if historical data indicate chemicals are present at concentrations exceeding the MCLs, HGALs, or NAWQCs. • Certain wells with isolated detections of chemicals at concentrations exceeding the MCLs, HGALs, or NAWQCs will be selected for resampling. • Some wells surrounding previously identified RUs will be selected for resampling even if their historical data do not indicate the presence of chemicals at concentrations exceeding the MCLs, HGALs, or NAWQCs. The purpose of selecting these wells is to evaluate (1) the extent of the current RUs and (2) the potential for plume migration.

Notes:

ARAR Applicable or relevant and appropriate requirement
COPC Chemical of potential concern
FS Feasibility study
FSP Field sampling plan
GDGI Groundwater data gaps investigation
GIS Geographic information system
HGAL Hunters Point groundwater ambient level
HPS Hunters Point Shipyard
MCL Maximum contaminant level
NAWQC National Ambient Water Quality Criteria
RU Remedial unit
TDS Total dissolved solids
VOC Volatile organic compound

A1.4.1 Step 1 – State the Problem

Step 1 of the DQO process identifies the specific problem that requires investigation.

Four specific problems requiring investigation are identified in Step 1:

1. <u>Well Condition Survey</u>

   Most monitoring wells on HPS have not been sampled in more than 4 years, and their conditions are unknown.

2. <u>Water Level Measurement Study</u>

   The most current A-aquifer potentiometric surface map was generated more than 4 years ago and may not reflect current groundwater flow conditions. Recharge and discharge from utility lines may be affecting groundwater flow. Potential ground settling may affect current groundwater elevations.

3. <u>B-Aquifer Study</u>

   The extent of contamination in the B-aquifer and its relationship to the A-aquifer at Parcels C and D (and potentially at a part of Parcel B) have not been evaluated because chemical and hydrogeologic data are insufficient to support an evaluation.

   Further, data on total dissolved solids (TDS) and yield are insufficient to evaluate if cleanup to drinking water standards is necessary.

4. <u>A-Aquifer and Bedrock Water-Bearing Zone Study</u>

   Existing A-aquifer and bedrock water-bearing zone ecological and human health RUs were developed on the basis of chemical data collected more than 4 years ago.

A1.4.2 Step 2 – Identify the Decision

The purpose of this step is to define the decision statement that combines the key question the study will attempt to resolve with the alternative actions that may be taken.

The questions used to identify the decision(s) for each tenet in Step 2 are:

1. <u>Well Condition Survey</u>

   Which monitoring wells are in a condition that requires repair or redevelopment before samples are collected or water level measurements are taken?

   Which monitoring wells are in a condition that requires decommissioning and replacement before samples are collected or water level measurements are taken?

2. Water Level Measurement Study

   What is the current potentiometric surface of the A-aquifer (particularly in the vicinity of existing groundwater RUs)?

3. B-Aquifer Study

   What is the nature and extent of contamination in the B-aquifer in (1) areas in which Bay Mud does not separate the A- and B-aquifers and (2) areas in which the overlying A-aquifer is impacted by volatile organic compounds (VOC)?

   What are the hydrogeologic conditions of the B-aquifer (particularly in the vicinity of existing A-aquifer groundwater RUs)?

   Do TDS and yield values in the B-aquifer meet the state or federal criteria for exemption from potential use as a drinking water source?

4. A-Aquifer and Bedrock Water-Bearing Zone Study

   Are the RUs representative of current conditions at the site?

A1.4.3 Step 3 – Identify the Inputs to the Decision

The purpose of this step is to identify the information needed to support the decision statement and to specify which inputs will require environmental measurements.

Identified inputs to the decision for each tenet in Step 3 are:

1. Well Condition Survey

   A comprehensive survey of the condition of all existing monitoring wells was conducted. The survey included measurement of the total depth of the well to assess silt buildup, measurement of the depth to water to compare the current water level with historical levels, measurement of the thickness of product to compare to historical levels, and a visual inspection of the general integrity of the well.

2. Water Level Measurement Study

   A sounder was used to collect basewide water level measurements from approximately 187 existing A-aquifer locations (as detailed in the FSP).

   Water level measurement data will be evaluated and the potentiometric surface will be interpreted by (1) an appropriate numeric interpolation technique and (2) modification by a California Registered Geologist (RG).

   A survey was conducted to determine the elevations of the tops of well casings at 24 existing well locations as control points for comparison to existing survey data. In addition, approximately 65 wells with incomplete survey data were surveyed.

3. B-Aquifer Study

Samples collected from six existing B-aquifer wells (including two nested A- and B-aquifer well pairs) and approximately 20 new A- and B-aquifer well pairs (as detailed in the FSP) will be analyzed for vertical gradient, yield, TDS, chemical concentrations, porosity, permeability, and geology.

Validated chemical data (with detection limits below the relevant ARARs) for chemicals of potential concern (COPC) in groundwater will be collected from existing and new B-aquifer wells.

Chemical data will be mapped in plane view and cross-section and entered into the geographic information system (GIS) database to establish the extent of contamination in the B-aquifer.

Groundwater elevation data from 18 existing B-aquifer wells (in Parcels C and E) and approximately 20 new B-aquifer wells (in Parcels B, C, and D, to be determined in FSP) will be used to assess the magnitude and direction of the horizontal gradient of the B-aquifer.

4. A-Aquifer and Bedrock Water Bearing-Zone Study

Validated chemical data (with detection limits below the relevant ARARs) for COPCs in groundwater will be collected from the existing 68 A-aquifer and 14 bedrock water-bearing zone wells, as detailed in the FSP.

A1.4.4 Step 4 – Define the Study Boundaries

The purpose of this step is to define the site characteristics in terms of the spatial and temporal boundaries that the environmental measurements are intended to represent. The spatial boundaries of the sites are those that define the area to be studied. The temporal boundaries of the sites are those that describe the time frame of the study data and when proposed samples should be collected.

The study boundaries for each tenet in Step 4 are defined as follows:

1. Well Condition Survey

The spatial boundaries of the well condition survey are all existing monitoring wells at HPS.

The temporal boundary of the well condition survey is 4 weeks.

2. Water Level Measurement Study

The areal limits of the water level measurement study area consist of A-aquifer wells at HPS that have been previously sampled. The areal limits of the survey measurements are the boundaries of the facility.

The vertical limit of the water level measurement study area is the depth of the A-aquifer wells that have been previously installed at HPS. The vertical limit of the survey measurements is the ground surface or the top of the casing, whichever is appropriate.

The temporal limit of the basewide water level measurement event is a period that will begin 1 hour before a high or low tide and will not extend beyond 3 hours after the same high or low tide. The temporal limit of the Phase I water level measurement study is 2 weeks (during which the wells will be sampled once). A Phase II water level measurement event will also be conducted to account for seasonal variations. The temporal limit of the Phase II study is 1 week.

3. B-Aquifer Study

The areal limits of the B-aquifer study area are the boundaries of Parcels B, C, D, and E.

The vertical limit of the B-aquifer study area is a depth of 5 feet below the bottom of the B-aquifer or to the bottom of VOC contamination, whichever is less.

The temporal limit of the B-aquifer study is 1 month (in which the wells will be installed and sampled once). A Phase II B-aquifer study will be conducted to account for seasonal variations.

4. A-Aquifer and Bedrock Water-Bearing Zone Study

The areal limits of the A-aquifer and bedrock water-bearing zone study area are the boundaries of Parcels B, C, and D.

The vertical limit of the A-aquifer and bedrock water-bearing zone study area is the thickness of the A-aquifer and the depth of the bedrock water-bearing zone wells installed within the boundaries of Parcels B, C, and D.

The temporal limit of the A-aquifer and bedrock water-bearing zone study is 2 weeks (in which the wells will be sampled once). A Phase II A-aquifer and bedrock water-bearing zone study will be conducted to account for seasonal variations.

A1.4.5 Step 5 – Develop a Decision Rule

Step 5 of the DQO process defines the statistical parameter of interest, specifies the action level, and integrates study outputs into a single statement that describes the logical basis for choosing among alternative actions. Step 5 essentially delineates the consequences of the study results. Decision rules may be formulated as “if . . . then” statements, in which the outcome of the investigation provides direction for the next stage of the problem resolution. For example, if contamination is not detected, then the site may proceed to no further action; however, if contamination is found, then the site may proceed to remediation or further investigation that defines the conditions that will cause decision-makers to choose among alternative actions.

One key point related to Step 5 is that the investigator should confirm that the specified action levels are greater than the detection and quantitation limits identified in Step 3, Identify the Inputs to the Decision. Analytical methods should be selected with both action levels and budgetary constraints in mind.

Decision rules developed for each tenet in Step 5 are:

1. Well Condition Survey

   If a monitoring well has minor damage (for example, a damaged surface casing), then repairs to such damage will be made.

   If a monitoring well has significant damage (for example, a damaged well casing) that is beyond repair, then the well will be decommissioned. If the well location is deemed necessary for future monitoring, then the well will be replaced.

   If there is visual evidence that surface contamination is entering the well casing, then the well will be redeveloped, decommissioned, replaced, or reassessed, as appropriate.

   If a monitoring well is not damaged and does not show signs that surface contamination is entering the well casing, then no action will be taken before samples are collected.

   If well sediment covers less than 10 percent of the well screen interval, then no redevelopment will be considered necessary.

   If well sediment covers 10 to 50 percent of the well screen interval, then the well will be redeveloped.

   If well sediment covers more than 50 percent (or 3 feet, whichever is greater) of the well screen interval, then the well will be decommissioned. If the location is deemed necessary for future monitoring, then the well will be replaced.

2. Water Level Measurement Study

   If the interpreted potentiometric surface at a given parcel predicts different flow directions when compared with historical data collected during the same season and at the same location, then the data may be further evaluated, depending on whether groundwater contamination is present, to identify the cause of the inconsistency.

   If the interpreted potentiometric surface at a given parcel predicts different flow directions when compared with historical data collected in the same season and at the same location and groundwater flow potentially affects RUs, then potential flow impacts from utility lines will be evaluated; utility lines will be repaired, if necessary; and new water level measurements will be collected.

If the interpreted potentiometric surface at a given parcel predicts different flow directions when compared with historical data collected in the same season and at the same location, groundwater flow in the area potentially affects RUs, and the data were not collected near utility lines, then (1) pressure transducers may be installed to confirm the data, or (2) the data will be used to create an updated potentiometric surface map.

If the interpreted potentiometric surface at a given parcel does not predict different flow directions when compared with historical data collected in the same season and at the same location, then no action will be taken.

If the survey data for more than 30 percent of the resurveyed wells varies by more than 0.05 foot when compared with historical elevation data, then an additional 20 wells will be resurveyed before the groundwater elevation measurements are taken (additional survey data will be evaluated using same decision rule).

If the survey data for more than 30 percent of the resurveyed wells does not vary by more than 0.05 foot when compared with historical elevation data, then no action will be taken.

3. B-Aquifer Study

Evaluate chemical and hydrogeologic data to assess the nature and extent of B-aquifer contamination. If data indicate that A-aquifer contamination has migrated to the B-aquifer and is not adequately characterized, then additional sampling locations will be proposed for Phase II sampling to characterize the extent of the plume.

If a B-aquifer area does not contain chemicals at concentrations that exceed the most stringent primary MCL or Hunters Point groundwater ambient level (HGAL) (or National Ambient Water Quality Criteria [NAWQC], as applicable), then the area will not be evaluated in the FS.

Evaluate TDS and yield data from the B-aquifer and compare those data with state and federal exemption criteria for drinking water sources. If a B-aquifer area contains chemicals at concentrations that exceed the most stringent primary MCL or HGAL, but the area meets the state and federal exemption criteria, then ecological risk and human health risk through the inhalation exposure pathway will be evaluated, and areas that are found to pose risks through those pathways will be evaluated in the FS.

If a B-aquifer area contains chemicals at concentrations that exceed the most stringent primary MCL or HGAL and the area does not meet the state and federal exemption criteria, then the area will be evaluated in the FS. Note: If a B-aquifer area that meets the above criteria is affected by a chemical plume that exceeds the most stringent primary MCL or HGAL, then the entire plume will be evaluated in the FS, regardless of the state and federal exemption criteria.

4. A-Aquifer and Bedrock Water-Bearing Zone Study

Chemical data will be used to revise the boundaries of the existing RUs. Revisions will be made on the basis of the following decision rules:

- If the results for both sampling rounds at a well are below the MCLs or NAWQCs, then the boundaries of the existing RU will be revised (reduced) to reflect that change.
- If the results of one or both sampling rounds at a well are not below the MCLs or NAWQCs, then the well will be retained in the RU; however, the boundary may be adjusted as necessary to reflect any changes.
- If concentrations indicate that a plume has migrated, then additional sampling locations will be proposed for Phase II sampling to characterize the extent of the plume.

A1.4.6 Step 6 – Specify Limits on Decision Errors

Step 6 of the DQO process quantifies the acceptable limits on decision errors. Such limits are needed to establish the level of uncertainty that will be acceptable and agreed upon by all stakeholders (such as regulatory agencies, citizens, and site owners). The acceptable level of error should be based on a consideration of the consequences of making an incorrect decision; that is, consequences of both false-positive and false-negative errors should be evaluated.

The quality of analytical data is also assessed under this step. Typically, the quality assessment involves specification of performance criteria in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the data. The performance criteria, termed the PARCC parameters, are discussed in Section A5.5 of this QAPP.

For each tenet in Step 6, judgmental sampling is being utilized; therefore, a statistical model is not appropriate. Measurement quality objectives in the form of precision and accuracy goals (discussed in Section A5.5) are designed to minimize analytical errors.

A1.4.7 Step 7 – Optimize the Design for Obtaining Data

The purpose of Step 7 of the DQO process is to identify a resource-effective design for generating environmental data that will meet the DQOs discussed in the previous sections.

In developing the sampling scheme for this groundwater monitoring program, several factors were evaluated. Those factors included monitoring well locations, sampling frequency, and analytes of concern. In addition to the 78 existing monitoring wells that are scheduled for sampling, 31 additional monitoring wells will be installed for this program. The new wells will be installed to better characterize the extent of contaminant plumes and to evaluate the B-aquifer.

Under this groundwater characterization program, analyses are proposed for specific contaminants: low-level contract laboratory program (CLP) VOCs; low-level CLP semivolatile organic compounds (SVOC); low-level CLP pesticides and polychlorinated biphenyls (PCB); CLP dissolved metals; total petroleum hydrocarbons-extractable (TPH-e); total petroleum hydrocarbons-purgeable (TPH-p); hexavalent chromium; and monitored natural attenuation (MNA) parameters. MNA parameters include reduced metals iron (II) (Fe^{2+}) and iron (III) (Fe^{3+}), nitrate, nitrite, sulfate, dissolved oxygen, oxidation-reduction potential, chloride, carbonate, calcium, magnesium, sodium, potassium, and TDS. Decisions about analyses for analytes of concern for groundwater samples (that is, sampling suites) are based on knowledge of potential contaminant source areas and the laboratory analytical results from previous groundwater sampling events.

Tenets to optimize the sampling design in Step 7 are:

1. Well Condition Survey

   Each well was photographed for documentation.

   Selection of sampling and measurement locations in the basewide groundwater sampling plan will be biased toward wells that do not require repair, redevelopment, or replacement, to the extent possible without compromising the objectives of the Phase I GDGI.

   Wells that are needed for the sampling program will be repaired, redeveloped, or replaced as necessary. Efforts to repair, redevelop, or replace existing wells will be conducted first at wells selected for sampling and measurement in the FSP.

2. Water Level Measurement Study

   Well locations were selected to provide general coverage throughout HPS, in addition to focusing on individual RUs. Additional wells may be installed to assess the potentiometric surface, as appropriate.

   The water level measurement period occurred during a period of relatively low tidal fluctuation in San Francisco Bay. The lowest fluctuation period during a 28-day lunar cycle is best, but may not be convenient because the high and low tides may occur during darkness. A low fluctuation period that allows groundwater measurement during daylight hours will be selected.

The sampling design is described in further detail in the FSP.

3. B-Aquifer Study

New A- and B-aquifer well locations will be selected according to the following guidelines:

- Wells will be placed near areas of known contamination in the A-aquifer (as discussed in working meetings with the BRAC Cleanup Team [BCT] in February and March 2000).
- Wells will be placed appropriately to define potential contaminant migration in areas in which Bay Mud does not separate the A- and B-aquifers.
- If groundwater flow direction in either the A- or the B-aquifer can be estimated, wells will be placed downgradient of known contamination.

4. A-Aquifer and Bedrock Water-Bearing Zone Study

The sampling design is described in further detail in the FSP.

Additional parameters may be collected to support remedial decisions and to evaluate technologies in the FS.

The following criteria will be used to select wells for additional sampling:

- Wells within previously identified RUs (chosen on the basis of ecological risk and human health risk through the inhalation exposure pathway) will be selected for resampling.
- Certain wells adjacent to previously identified RUs will be selected for resampling if historical data indicate that chemicals are present at concentrations that exceed the MCLs, HGALs, or NAWQCs.
- Certain wells for which there were isolated detections of chemicals at concentrations that exceed the MCLs, HGALs, or NAWQCs will be selected for resampling.
- Some wells adjacent to previously identified RUs will be selected for resampling even if their historical data do not indicate the presence of chemicals at concentrations that exceed the MCLs, HGALs, or NAWQCs. The purpose of selecting those wells is to evaluate (1) the extent of the current RUs and (2) the potential for plume migration.

A2 PROJECT AND TASK ORGANIZATION

This section discusses management of the Phase I GDGI. A well-organized project team, combined with adequate experience and proper training, will promote consistent quality throughout the investigation. Sections A2.1 and A2.2 present the task organization for the project, including the specific roles and responsibilities of project participants. Section A2.3 discusses training requirements for project members, and Section A2.4 identifies the schedule for the work to be conducted.

A2.1 PROJECT ORGANIZATION AND PERSONNEL

The following personnel are involved in the Phase I GDGI field efforts. In some cases, more than one responsibility has been assigned to a single individual.

Name	Responsibility	Location	Telephone
David DeMars	Navy Lead Remedial Project Manager	Naval Facilities Engineering Command, San Diego, CA	(619) 532-0912
Narciso Ancog	Navy QA Officer (QAO)	Naval Facilities Engineering Command, San Diego, CA	(619) 532-2540
Richard Mach	BRAC Environmental Coordinator	Naval Facilities Engineering Command, San Diego, CA	(619) 532-0913
Daniel Chow	Program Manager	TtEMI, San Francisco, CA	(415) 222-8222
Jason Brodersen	Installation Coordinator (IC)	TtEMI, San Francisco, CA	(415) 222-8225
Doug Bielskis	Project Manager	TtEMI, San Francisco, CA	(415) 222-8242
Greg Swanson	Program QA Manager	TtEMI, San Diego, CA	(619) 718-9676
Ron Ohta	Project QA Manager	TtEMI, Sacramento, CA	(916) 853-4506
Doug Sterling	On-site Quality Assurance Officer	TtEMI, San Francisco, CA	(415) 222-8270
Conrad Sherman	Program Health and Safety Manager (HSM)	TtEMI, San Francisco, CA	(415) 222-8377
William Warren	Project Health and Safety Coordinator	TtEMI, San Francisco, CA	(415) 222-8293
Deborah Cheng	On-site Health and Safety Officer	TtEMI, San Francisco, CA	(415) 222-8215
Rameen Moezzi	Project Chemist	TtEMI, San Francisco, CA	(415) 222-8278
Rob Morrow	Field Team Leader	TtEMI, San Francisco, CA	(415) 222-8262
Joan Humphreys	Database Manager	TtEMI, San Francisco, CA	(415) 222-8291
Susan Gallagher	Sample Tracking Coordinator	TtEMI, San Francisco, CA	(415) 222-8329

A2.2 PROJECT TEAM RESPONSIBILITIES

The roles and key responsibilities of each project team member are described in the following subsections. Figure A-3 shows an organization flow chart.

Navy Lead Remedial Project Manager

The Navy Lead RPM has overall responsibility for the IR Program and this Phase I GDGI. The Navy Lead RPM is directly responsible for project execution and coordination with representatives of the base, regulatory agencies, and the SWDIV management team.

The Navy Lead RPM is responsible for:

- Providing site information and history
- Providing logistical assistance
- Specifying sites that require investigation
- Reviewing results and recommendations and providing management and technical oversight
- Verifying proper review and distribution of documents
- Communicating comments from technical reviewers to contractors
- Verifying that contractors address comments and take appropriate corrective action
- Coordinating with regulatory agencies

Navy Quality Assurance Officer

The Navy QAO is responsible for QA issues for all Navy CLEAN II work. The Navy QAO provides government oversight of the QA program, including review and signature of QAPPs and FSPs. The QAO provides quality-related direction to the quality manager through the contracting officer’s technical representative. The QAO has authority to suspend affected project or site activities if quality requirements approved by SWDIV are not adequately met.

Navy BRAC Environmental Coordinator

The Navy BRAC Environmental Coordinator (BEC) has overall responsibility for all Navy activities at HPS. The BEC is responsible for overseeing all project activities and coordinating with representatives of the community, regulatory agencies, and other project stakeholders.

TtEMI Program Manager

The TtEMI Navy CLEAN II program manager is responsible for and has authority over all work by personnel assigned to the Navy CLEAN II program. The program manager establishes program policies and procedures, monitors costs and performance, delegates authority, and resolves conflicts and problems. The TtEMI program manager is responsible for:

- Verifying that contract requirements are met
- Providing necessary resources to the project team to allow adequate response to the requirements of the investigation
- Maintaining consistency in procedures and work products with other task orders
- Establishing and maintaining communication among the RPM, the QA manager, the HSM, and project managers
- Providing technical oversight and review of the final project report
- Providing guidance to the project manager
- Assisting the CLEAN II program QA manager in resolving QA issues that cannot be handled at the CTO project manager or quality control coordinator (QCC) level
- Assisting the CLEAN II program QA manager in resolving issues with subcontractors
- Monitoring CTO project managers' compliance with orders and recommendations
- Establishing and supporting continuous quality improvement (CQI) problem-solving teams and process improvement groups to follow through on program-specific quality and process improvement opportunities identified by the CLEAN II program QA manager and QC coordinator
- Providing TtEMI CTO project managers with revised standard operating procedures (SOP) received from the CLEAN II program QA manager and ensuring that the improved SOPs are followed

TtEMI Installation Coordinator

The TtEMI IC has overall responsibility for all TtEMI activities at HPS. Those activities are divided into CTOs. The IC is responsible for overseeing all project activities and coordinating with subcontractors.

TtEMI Project Manager

The project manager is responsible for overseeing project activities and coordinating with subcontractors. The project manager is ultimately responsible for the timely completion of the project.

The responsibilities of the project manager are:

- Verifying that QC requirements are fulfilled by team members
- Supervising the document control process
- Approving deliverables and associated documents before they are transmitted
- Establishing and maintaining communication among technical staff, program managers, QA officers, health and safety coordinators, and regulatory agencies
- Implementing programs and protocols related to the project
- Developing work plans that define the scope of major activities at the level of defensibility, documentation, and QC required for environmental measurements
- Developing specific QC procedures for major activities that produce or use environmental data
- Defining, reporting, and maintaining documentation of the PARCC of data
- Working with program management, QCCs, and other CTO project managers to develop, revise, and implement mechanisms, as needed, to identify QA problems and expedite corrective actions
- Verifying that data processing procedures are documented, routinely reviewed, and revised, as necessary
- Verifying that the CTO project team fulfills the QC requirements of the work plan
- Maintaining and regularly reviewing QA records and forwarding copies to the QC coordinators and the CLEAN II program QA manager
- Overseeing the technical review and QC check for deliverables and approving data, reports, specifications, drawings, and documentation before they are transmitted
- Establishing and maintaining communication among the CTO technical staff, the TtEMI QCCs, and the CLEAN II program QA manager
- Overseeing the preparation of QAPPs for any CTO that involves field data collection activities, such as sample collection, including specifying acceptance criteria for the quality of data

- Verifying by personal observation that appropriate sampling, field testing, and field analysis procedures, as specified in the work plan and QAPP, are followed and that correct QC checks are made

- Working with QCCs to implement quality improvements identified during audit and review of ongoing work

- Implementing and following approved SOPs received from the TtEMI program manager

- Controlling the identification and handling all documentation until it is turned over to designated document-control personnel

TtEMI Program Quality Assurance Manager

The program QA manager is responsible for the quality of all work completed by TtEMI and its subcontractors under the Navy CLEAN II program. The program QA manager develops and maintains a comprehensive QA program and is responsible for audits, reviews of all work performed, and recommendations to technical staff and management on matters related to quality. The program QA manager has the following specific responsibilities:

- Developing and revising the TtEMI Navy CLEAN II QA program

- Assigning qualified personnel to serve as project QA managers

- Implementing and supervising the QA program with the assistance of QCCs and subcontractor project QA managers

- Coordinating and auditing the review of QC documentation and technical operations, as required

- Reporting nonconformance situations to the CLEAN II program manager and the TtEMI corporate QA manager

- Providing guidance to CTO technical staff for QC program development and correcting nonconformance situations

- Preparing and revising SOPs and providing them to CTO project managers and technical staff

- Interacting with the Navy's appointed QAO about certification of laboratories and coordinating the compliance with requirements on the part of QA and technical staff

- Ensuring compliance with orders and making recommendations to the CLEAN II program manager and CTO project managers about corrective action

- Approving the waiver of requirements for a written QC procedure when SOPs are specified by the Navy and available for use

- Communicating regularly with the CLEAN II program manager and providing a summary of quality improvement opportunities to the CLEAN II program manager for further action

- Communicating regularly with and supervising QA responsibilities of QCCs, and coordinating and compiling quality improvement opportunities identified by QCCs

- Updating the TtEMI corporate QA manager on newly identified, ongoing, and completed program-specific quality improvement opportunities

- Communicating quality improvement opportunities identified by TtEMI to subcontractor QA managers and assisting subcontractor QA managers in pursuing quality improvement opportunities that will benefit the overall program QA effort

- Meeting regularly with the program managers, project managers, and QA managers

- Reviewing and approving QAPPs

- Conducting field audits to ensure that sampling activities are performed in accordance with the QAPP

The program QA manager reports, as necessary, to the corporate QA manager and consults frequently with the program manager and the project QA manager. The program QA manager refers QA issues or disputes that cannot be resolved within the Navy CLEAN II program to the TtEMI corporate QA manager.

TtEMI Project Quality Assurance Manager

A senior technical staff member will serve as project QA manager and will be responsible for review of work completed by TtEMI. The project QA manager, or the designated on-site QA officer, will audit and review work. The manager will provide recommendations about quality to the project manager and technical staff. The project QA manager will also regularly communicate with the CLEAN II program QA manager to discuss QA problems and resolutions of such problems. Specific responsibilities of the project QA manager are:

- Meeting regularly with the CLEAN II program QA manager

- Reviewing all deliverables before their release to ensure conformance with QA/QC procedures and the quality of the work product

- Providing recommendations to the program QA manager, as required, for corrective action related to all aspects of work that do not meet program standards

- Providing guidance to project teams for QC program development and for correcting nonconformance situations

- Coordinating compliance with specific QC requirements on the part of QC and technical staff

- Ensuring compliance with orders and making recommendations to CTO project managers about corrective action

- Identifying quality improvement opportunities as part of the audit and review function

- Communicating quality improvement opportunities to the program QA manager or CTO project managers, as appropriate

- Ensuring that the QAPP is prepared in accordance with the provisions of EPA guidance documents

- Ensuring that all protocols described in the QAPP are met

- Providing guidance or assistance in resolving problems related to QA/QC topics

- Verifying that the specified data collection methods comply with QA/QC requirements and will yield data of the desired quality and integrity

- Reviewing, evaluating, and approving quality-related changes in the FSP and project work plan

- Ensuring that all nonconformances are identified and appropriate corrective actions are taken; providing assistance to the project managers with regard to corrective action; and, if necessary, soliciting involvement on the part of the program manager and program QA manager

- Conducting laboratory evaluations and audits to ensure that analyses are performed in accordance with the provisions of the QAPP

- Communicating regularly with the project manager, program QA manager, and project chemist to ensure the progress of QA tasks for the project

- Serving as the main contact for project QA matters and providing guidance on appropriate procedures to the project managers and support personnel

TtEMI Technical Staff

TtEMI technical staff will be responsible to the CTO project manager and the project QA manager for completing project activities in compliance with approved SOPs, the QAPP, and other program and project QC guidelines and requirements. The technical staff has the following specific responsibilities:

- Collecting and generating field and laboratory data by carrying out activities in a manner consistent with the TtEMI quality management plan

- Generating control and calibration data so that the quality and usability of field and laboratory data can be evaluated

- Documenting sample control and data management procedures

- Documenting the sources of all information acquired, including manual and computer calculations, engineering drawings, and equipment specifications

TtEMI Program Health and Safety Manager

The program HSM is responsible for developing health and safety standards, implementing health and safety policies, and providing consultation to management for the Navy CLEAN program. Specific responsibilities of the HSM are:

- Keeping management informed of the status of the Navy CLEAN II health and safety program

- Providing consultation on health and safety policy and procedural issues

- Participating in audits to evaluate compliance with the HSP and the Navy CLEAN II health and safety program

- Reviewing the HSP for technical content and compliance with the requirements of the Navy CLEAN II health and safety program

- Developing, implementing, and assessing the needs of the Navy CLEAN II health and safety program and informing the project health and safety coordinators of changes in the program

- Providing consultation on health and safety policy and procedural issues as they are related to the Navy CLEAN II health and safety program

TtEMI Project Health and Safety Coordinator

The project health and safety coordinator is responsible for developing, instituting, coordinating, and supervising the health and safety program. The project health and safety coordinator's responsibilities are:

- Preparing and amending the basewide HSP, as necessary

- Providing assistance to the program HSM for health and safety program development, preparing training sessions, conducting accident investigations, and providing recommendations for preventing future accidents

- Ensuring that the HSP complies with federal, state, and local health requirements
- Coordinating with the on-site safety officers related to modifications of the HSP and providing consultation, when required
- Preparing materials to be used in the training program and ensuring that the TtEMI on-site safety manager is knowledgeable about the requirements of the HSP
- Conducting periodic on-site visits to verify that site personnel adhere to site safety requirements
- Establishing and maintaining communication among the on-site safety manager, the project manager, and the program HSM
- Providing guidance on appropriate corrective action procedures to the project manager and support personnel

TtEMI On-site Health and Safety Officer

The on-site health and safety officer is responsible for field implementation of the HSP and has the authority to correct and change site control measures and the required health and safety protection. The on-site health and safety officer has primary on-site enforcement authority, as delegated by the project manager, for the policies and provisions of the health and safety program and the HSP. Responsibilities of the on-site health and safety officer are:

- Serving as the initial contact for site-specific health and safety activities
- Conducting briefing sessions for and providing documentation to TtEMI and subcontractor personnel concerning site-specific hazards, emergency procedures, and symptoms associated with exposure to specific site contaminants
- Documenting health and safety briefings, meetings, and training that are completed in the field
- Selecting the required personal level of protection on the basis of guidance given in the basewide HSP and actual on-site operations
- Establishing, enforcing, and documenting decontamination operations for personnel and sampling equipment, sample containers, and heavy equipment
- Suspending any operation that threatens the health or safety of team members or the neighboring population and immediately notifying the project manager
- Determining and posting locations and routes to medical facilities, arranging for emergency transportation to medical facilities, and posting telephone numbers of emergency services

- Assuming the lead role for TtEMI during medical emergency
- Along with other TtEMI field personnel, providing on-site cardiopulmonary resuscitation (CPR) and first aid, as necessary

TtEMI Project Chemist

The TtEMI project chemist works with the task manager during preparation of the FSP and QAPP. Those tasks include coordinating the analytical tests in a manner consistent with the type and quality of analytical data required for the project, setting up the contract analytical laboratories, coordinating validation of laboratory analytical results, and providing the procurement office with the information necessary to procure any special analysis. The responsibilities of the project chemist are:

- Verifying that the laboratory implements the requirements of the FSP and QAPP
- Coordinating pickup and delivery schedules and QA/QC matters with the contract laboratory
- Conducting laboratory evaluations and audits
- Reviewing laboratory data before their release
- Coordinating data validation activities
- Providing updates on the project to project QA officers and managers with regard to the QA/QC data

TtEMI Field Team Leader

The TtEMI field team leader is responsible for field activities. The field team leader will direct all on-site activities, including those of subcontractors, and will ensure that the field team adheres to procedures described in the FSP.

TtEMI Database Manager

The database manager coordinates loading and checking data in the database. The TtEMI database manager is also responsible for interacting with the project chemist during preparation of the FSP and QAPP to address sample identification issues. In addition, the database manager is responsible for working with the project chemist and the field team leader to prepare for the field sampling effort. The project database manager is responsible for all aspects of developing and monitoring the database under the guidance of the project manager, as follows:

- Designing the database
- Selecting software
- Coordinating data submittals
- Logging and transferring data
- Entering and verifying data
- Developing screen and report formats
- Archiving data
- Assisting users in accessing and retrieving data
- Documenting the database
- Distributing the database
- Verifying software verification and change approvals
- Verifying and documenting all changes in the existing data

TtEMI Sample Tracking Coordinator

The TtEMI sample tracking coordinator is responsible for interacting with the project chemist, database manager, and subcontracted laboratory to ensure that analytical procedures requested on the chain-of-custody form are followed, sample identifiers are correct, and sample information is correctly entered into the database. In addition, the sample tracking coordinator is responsible for working with the project chemist to organize data validation.

A2.3 SPECIAL TRAINING AND CERTIFICATION

Personnel who work at a hazardous waste project site are required to meet the Occupational Safety and Health Administration (OSHA) health and safety training requirements set forth under 29 Code of Federal Regulations (CFR) Part 1910.120(e), as described in the following sections. Depending on individual responsibilities in the field and the complexity of a particular project, it may be necessary that on-site personnel meet special training requirements defined in the work plan for the CTO. The following sections describe the training requirements for TtEMI personnel and subcontractors.

A2.3.1 Personnel Health and Safety Training

TtEMI personnel working on hazardous waste project sites who are responsible for the project or site activities are required to undergo specific training before participating in, managing, or supervising field activities. The training must thoroughly cover the following areas:

- Names of personnel and alternates responsible for health and safety at a hazardous waste project site
- Health and safety hazards present on site
- Selection of the appropriate levels of personal protection
- Correct use of personal protective equipment (PPE)
- Work practices that minimize risks from hazards
- Safe use of engineering controls and equipment on site
- Medical surveillance requirements, including recognition of symptoms and signs that might indicate overexposure to hazardous substances
- Contents of the basewide HSP

TtEMI personnel engaged in activities that may expose workers to hazardous substances and health hazards will receive a minimum of 40 hours of formal instruction off site and at least 3 days of actual field experience on site, under the supervision of a trained, experienced field supervisor. Field personnel who are directly responsible for, or who supervise employees engaged in, hazardous waste operations will also receive the 40 hours of initial training, 3 days of supervised on-site field experience under a trained supervisor, and at least 8 additional hours of specialized supervisor training. The specialized training will include the requirements of the CLEAN II health and safety program, the PPE and personal level of protection programs, the spill containment program, and procedures and techniques for monitoring health hazards. TtEMI's on-site safety manager will receive an additional 8 hours of supervisor training. The on-site safety manager will also receive additional health and safety training, including training in operating monitoring instruments.

Written certificates will be presented to all employees who successfully complete the training. To maintain certification, TtEMI employees engaged in work at hazardous waste sites are required to undergo 8 hours of annual refresher training.

The TtEMI field team leader, who is the on-site manager who has authority delegated by the project manager to direct field operations, will be fully trained in hazardous waste field operations and will ensure that all necessary preparation and coordination have been completed before on-site work begins. Such preparation generally consists of drafting project documents, such as the work plan, the FSP, the QAPP, and requests for subcontractor bids. In some cases, a field team leader trains for the position by working on site as a team member.

At least one member of every TtEMI field team will maintain current certification in the American Red Cross Multimedia First Aid and Cardiopulmonary Resuscitation Modular courses, or their equivalent. The program HSM ensures that appropriate field personnel maintain current certification in both first aid and CPR.

Copies of TtEMI's health and safety training records, including course completion certifications for the initial health and safety training, first aid, CPR, and refresher training, will be maintained in project files. The program HSM implements the training requirements by notifying employees when recertification is due, disseminating information about appropriate courses, and conducting or assisting in refresher training and related tasks.

A2.3.2 Subcontractor Training

Subcontractors that work on site will certify that their employees have been trained for work on hazardous waste project sites. The training will meet the OSHA requirements at 29 CFR Part 1910.120(e). Before beginning work at the project site, the subcontractors will submit to the program HSM certification of training for each employee who will be involved in field work. Subcontractors also will ensure that those employees attend a pre-entry safety briefing.

The pre-entry safety briefing is designed to inform subcontractor employees of the potential risks associated with working with hazardous materials, site-specific hazards, the required level of personal protection, and the correct use of PPE. The safety briefing is conducted by the on-site safety manager or other qualified person designated by the program HSM. Employees of associate and professional services firms and technical service subcontractors will attend a safety briefing before conducting on-site work. Construction service subcontractors are responsible for conducting their own safety briefings. TtEMI personnel may audit the briefings.

Job hazards for most environmental investigation field tasks are described in the basewide HSP (PRC 1996c). Section 4.0 of the basewide HSP discusses hazard identification and analysis and describes physical, industrial, chemical, and biological hazards.

A2.4 PROJECT SCHEDULE

The implementation schedule for sampling, analysis, and associated reporting is presented in Table 8-1 in the accompanying FSP.

A3 SITE BACKGROUND AND PROBLEM DEFINITION

As detailed in Section A1.4, the following four tasks will be conducted as part of the Phase I GDGI:

- Assess the condition of all existing groundwater wells
- Measure basewide water levels to determine the pieziometric surface at existing A- and B-aquifers wells
- Perform additional B-aquifer characterization in Parcels C and D by sampling existing and newly installed wells for hydrogeologic and chemical parameters
- Resample A-aquifer wells in Parcels C and D for chemical parameters to characterize the extent of contamination

The majority of existing groundwater monitoring wells at HPS was installed during RI activities conducted between 1990 and 1995. Well construction details are included in Appendix D of the accompanying FSP. Future well installation and development activities under the Phase I GDGI will be consistent with procedures specified in the International Technology Corporation (IT) Remedial Action Work Plan, Revision 9 (see Section 10.0, References, in the FSP) and IT SOP 8.1 and 8.2 (see Appendix E of the accompanying FSP). Groundwater sampling methods will be consistent with the procedures presented in TtEMI SOPs No. 010 and 015 (see Appendix C of the FSP). Static groundwater levels will be measured in select wells throughout HPS, as specified in the FSP.

Complete background information, such as geologic data on San Francisco Bay and HPS and information about HPS and site-specific operational histories, environmental restoration activities, and the results of environmental investigation and analysis, is presented in the RI reports (PRC 1996a, 1997a, 1996b, 1997b), and the FS reports (PRC 1996c, 1997c; TtEMI 1998a, 1998b).

The following sections present summary site backgrounds and describe in detail the purpose of the Phase I GDGI at Parcels C and D. Site backgrounds for Parcels B and E are not presented since only the well condition survey and groundwater level measurements are conducted within these parcels. A summary of data collection requirements, including the proposed analytical suite, can be found in Table 4-4 of the accompanying FSP.

A3.1 PARCEL C

Parcel C areas that have significant groundwater contamination are located in IR-25 and IR-28, as shown on Figure A-2. A brief background of each IR site and a general description of the purpose of the current investigation at Parcel C are presented below.

A3.1.1 Background

This section discusses background information for IR-25 and IR-28.

IR-25

IR-25 is located in the northwestern corner of Parcel C and covers approximately 1.5 acres. Building 134, the only structure within IR-25, was formerly used by the Navy as a machine shop and an industrial laboratory. Potential sources of contamination at IR-25 include releases from a concrete dip tank and degreasing vat at the northwest end of Building 134 and releases from subsurface fuel lines located beneath the central portion of the building. Primary chemicals of concern in groundwater at IR-25 include VOCs, SVOCs, PCBs, and petroleum hydrocarbons. Groundwater in the area surrounding the dip tank was identified in the draft final Parcel C FS (TtEMI 1998a) as RU-6 on the basis of human health risk (through the inhalation pathway) and ecological risk to aquatic receptors; however, during recent working meetings conducted to evaluate Parcel C groundwater on the basis of the drinking water pathway, the area was slightly expanded and renamed RU-C5.

IR-28

IR-28 is the central IR site in Parcel C and covers approximately 24.5 acres. Buildings within IR-28 were used for a variety of industrial purposes; most notably, Buildings 231, 211/253, 251, and 272 were used primarily for machining and electronics testing. The potential sources of contamination at IR-28 are releases from former underground storage tanks (UST), aboveground storage tanks (AST), dip tanks, and subsurface sumps, trenches, and piping. Primary chemicals of concern in IR-28 groundwater include

VOCs, metals, PCBs, and petroleum hydrocarbons. In the draft final Parcel C FS (TtEMI 1998a), the following five remedial units were identified on the basis of the human health risk (through the inhalation pathway) and ecological risk to aquatic receptors: RU-1 (northeast of Building 231), RU-2 (Buildings 231 and 211/253), RU-3 (southwest of Building 211/253), RU-4 (Building 272), and RU-5 (Building 251). During recent working meetings conducted to evaluate Parcel C groundwater on the basis of the drinking water pathway, several of those remedial areas were slightly expanded and renamed as follows (shown on Figure A-2).

Current Remedial Units	FS Remedial Units
RU-C1	RU-2, RU-7
RU-C2	RU-5
RU-C4, RU-C7	RU-4

A3.1.2 Purpose of the Current Investigation

The purpose of the current investigation is to characterize existing data gaps in IR-25 and IR-28 as follows:

- Collect water level measurements from existing and newly installed A- and B-aquifer wells to determine horizontal and vertical gradients
- Collect updated chemical data from existing and newly installed B-aquifer wells to characterize the vertical extent of contamination on the basis of the drinking water pathway, particularly in areas in which no Bay Mud aquitard separates the shallow A-aquifer from the underlying B-aquifer (RU-C1, RU-C2, RU-C4, RU-C5, and RU-C7),
- Collect updated chemical data from existing A-aquifer and bedrock water-bearing zone monitoring wells to confirm the horizontal extent of RUs, on the basis of the drinking water pathway.

A3.2 PARCEL D

The Parcel D RI and FS reports (PRC 1996b; TtEMI 1997c) stated that groundwater at Parcel D does not pose an unacceptable human health risk (through the inhalation pathway) or an unacceptable ecological risk to aquatic receptors; however, during recent working meetings conducted to evaluate Parcel D groundwater on the basis of the drinking water pathway, several areas of potential concern were identified in sites IR-09, IR-33 North, IR-33 South, IR-34, and IR-71. A brief background of each IR site and a general description of the purpose of the current investigation at Parcel D are presented below.

A3.2.1 Background

This section discusses the background of each of the sites at which areas of potential concern have been identified.

IR-09

IR-09, the Pickling and Plate Yard, covers approximately 2.75 acres in the north-central portion of Parcel D. It was used by the Navy from 1947 and 1973 for industrial metal finishing and painting. Potential contaminant sources at IR-09 are:

- Release of spent acid rinse water from pickling operations discharged monthly to the formerly combined sanitary and storm drain sewer system.
- Zinc chromate primer residue from painting operations formerly on the ground surface and various structures at IR-09
- Leaks from subsurface sulfuric and phosphoric acid dip tanks (that is, the pickling tanks).

Metals (most notably chromium, hexavalent chromium, and nickel) are the primary chemicals of concern in groundwater at IR-09. During recent working meetings conducted to evaluate Parcel D groundwater on the basis of the drinking water pathway, a portion of IR-09 was identified as an area of potential concern and was identified as RU-D1, as shown on Figure A-2.

IR-33 North

IR-33 North (IR-33N) lies in the northern portion of Parcel D and covers approximately 4.5 acres. Operations performed at IR-33N include a transportation shop for repair of automotive and locomotive equipment (Building 302); a former transportation shop annex (Building 302A), in which vehicle repair, sandblasting, and painting operations were performed; a former service station (Building 304); and two 7,000-gallon gasoline USTs (S-304 and S-305) located adjacent to Building 304. Potential contaminant sources identified at IR-33N are:

- Waste oil storage tanks and sumps at Building 302
- Wastewater containing detergents, degreaser, and decarbonizers at Building 302
- Waste oil, diesel fuel, antifreeze, paints, and solvents stored at Building 302A

- Oils, fuels, and hydraulic fluids used at Building 304
- Gasoline from former USTs S-304 and S-305

Chromium, benzene, and petroleum hydrocarbons are the primary chemicals of concern in IR-33N groundwater. During recent working meetings conducted to evaluate Parcel D groundwater on the basis of the drinking water pathway, additional sampling was deemed necessary to evaluate concentrations of chromium and benzene. In addition, wells at IR-33N that contain petroleum hydrocarbons will be resampled and the results evaluated in the corrective action plan.

IR-33 South

Site IR-33 South (IR-33S) is in the central portion of Parcel D (directly south of IR-09) and covers approximately 6 acres. Operations performed at IR-33S include the Naval Radiological Defense Laboratory (NRDL) (Building 364); an office for pipe fitters (Building 365); a steel, shipfitter's, boilermaker's, and welder's and burner's shop (Building 411); a staging area for hazardous waste hauling activities, storage of equipment and waste, and cleaning and light maintenance of vehicles (Buildings 417, 418, and 424). Nickel is the primary chemical of concern in IR-33S groundwater. During recent working meetings conducted to evaluate Parcel D groundwater on the basis of the drinking water pathway, a portion of IR-33S was identified as an area of potential concern and was subsequently designated as RU-D1 (contiguous with RU-D1, located in IR-09).

IR-34

Site IR-34 is near the central portion of Parcel D and covers approximately 5 acres. Operations performed at IR-34 include the electronics shop (Buildings 351 and 351A, part of the former NRDL), used for maintenance, including cleaning and painting of electronic equipment, and a former Boat and Plastics Shop (Building 366). Potential contaminant sources identified at IR-34 are:

- Detergents, thinners, solvents, epoxies, waste oil, and hydraulic fluid from operations at Buildings 351, 351A, and 366
- Electrolyte solutions that contain metals from the storage of batteries near Building 366

Chromium is the primary chemical of concern in IR-34 groundwater. During recent working meetings conducted to evaluate Parcel D groundwater on the basis of the drinking water pathway, additional sampling was deemed necessary to evaluate concentrations of chromium.

IR-71

Site IR-71 is located in the east-central portion of Parcel D and covers approximately 1 acre. Site IR-71 is currently used for storage of complete and partially dismantled cranes. The northern portion of the site is designated Area I. In addition to leaking of lubricating and waste oil from the dismantled crane equipment, fuel tanks reportedly leaked into the soil in Area I. The southern portion of the site is designated Area II. The soil is stained with oil and fuel from the ASTs believed to have been stored in the area. Black- and tan-colored sand is also present in a large shed located in Area II. The sand is believed to be associated with sandblasting operations. Potential contaminant sources identified at IR-71 are:

- Petroleum hydrocarbons from waste and lubricating oils and fuel
- Metals from possible sandblast abrasive

VOCs are the primary chemicals of concern in IR-71 groundwater. During recent working meetings conducted to evaluate Parcel D groundwater on the basis of the drinking water pathway, additional sampling was deemed necessary to evaluate concentrations of VOCs.

A3.2.2 Purpose of the Current Investigation

The purpose of the current investigation is to characterize existing data gaps for IR-09, IR-33N, IR-33S, IR-34, and IR-71, as follows:

- Collect water level measurements from existing and newly installed A- and B-aquifer wells to determine horizontal and vertical gradients
- Collect updated chemical data from existing and newly installed B-aquifer wells to characterize the vertical extent of contamination on the basis of the drinking water pathway, particularly in areas in which no Bay Mud aquitard separates the shallow A-aquifer from the underlying B-aquifer (IR-09, IR-33S, and IR-34)
- Collect updated chemical data from existing A-aquifer and bedrock water-bearing zone monitoring wells to determine whether further evaluation is necessary based on the drinking water pathway

A4 PROJECT AND TASK DESCRIPTION

The following paragraphs summarize the objectives of and the tasks necessary to complete the HPS Phase I GDGI. The primary objectives, types of data to be collected, quality standards and criteria for those data, and project documentation are discussed below. The DQO steps for the project are presented in Table A-2 of this QAPP. A general discussion of DQO steps is provided in Section A1.4 of this QAPP, and specific details related to each DQO step are discussed throughout this document.

A4.1 PROJECT OBJECTIVES

The overall project objective is to better characterize the HPS groundwater gradient (horizontal and vertical) and the extent of groundwater contaminant plumes. Specific project objectives, as related to the resolution of study questions, are discussed in detail in Section A1.4.

A4.2 PROJECT MEASUREMENTS

The analytical methods were selected to provide data of the quality necessary to meet the DQOs for this project and to maintain the consistency and comparability of the data. The data collected under the current groundwater monitoring program must be comparable to previously collected HPS groundwater data to allow evaluation of decisions identified through the DQO process (Section A1.4). To promote comparability of data with previous analytical results, CLP methods were chosen for the majority of analyses. Laboratory analytical methods and corresponding detection and reporting limits are presented in Appendix 2 of this QAPP. In addition, low-level analytical methods will be used for VOCs, SVOCs, and PCBs because those methods are sufficient to meet detection limits required for comparison with the screening criteria identified (Table 2-2 in Appendix 2 of this QAPP).

A4.3 PROJECT QUALITY STANDARDS AND CRITERIA

To promote the quality and consistency of data acquisition and evaluation during the facilitywide groundwater investigation, all project activities will be completed in accordance with this QAPP and the accompanying FSP. The QAPP describes the technical and quality objectives of the project, intended data collection methods that are appropriate for achieving those objectives, assessment procedures that are adequate for confirming that data of the type and quality needed and expected are obtained, and any identified limitations on the use of those data.

To promote defensible and acceptable quality, laboratory analytical data generated during this project will undergo validation and verification. Data validation and usability are discussed further in Section D1 of this QAPP. An independent third-party contractor will validate data in accordance with Navy SWDIV Environmental Work Instruction (EWI) 4EN.1 (EWI #1) (SWDIV 1999). Since HPS is listed on EPA's National Priorities List, a minimum of 20 percent of the laboratory analytical data will be randomly selected and fully validated. All remaining analytical data will undergo cursory validation.

The assessment tools needed to verify that data quality will be maintained throughout the study activities include QC reviews, such as technical, editorial, and QCC reviews, of project documents; performance and system audits; and laboratory QA/QC procedures. Project audits are described further in Section C1.1 of this QAPP. Laboratory QA/QC procedures are addressed in Section B6 of this QAPP.

A4.4 PROJECT DOCUMENTATION

The following section describes how field documentation and records are maintained. Additional information about sample and location nomenclature is provided in Section 6.0 of the accompanying FSP. Sample documentation, such as sample labels, chain-of-custody procedures, and packaging and shipping procedures, are discussed in Section B4 of this QAPP.

The following field forms will be maintained as appropriate for this field activity at HPS:

- Field instrument calibration log
- Monitoring well inspection form
- Monitoring well completion record
- Groundwater level measurements log
- Monitoring well sampling sheet
- Chain-of-custody form
- Daily quality control report form
- Audit report form
- Corrective action request form

The forms, which are provided in Appendix 1 of this QAPP, will be used as source documents in support of the HPS database. The following general guidelines for maintaining field documentation will be used:

- Documentation will be completed in permanent black ink.
- All entries will be legible.
- Errors will be corrected by crossing out with a single line and dating and initialing the lineout.
- Any serialized documents will be maintained on site and referenced in the site logbook.

Field personnel will use permanently bound field logbooks with sequentially numbered pages to maintain field records. The front cover of the logbook will list the contract name and number, the CTO number, the site name, names of subcontractors, the client, and the name of the project manager. At a minimum, the following information will be recorded in the field logbook:

- Name and affiliation of all personnel or visitors on site
- Weather conditions during the field activity
- Log and summary of daily activities and significant events
- Notes of conversations with coordinating officials
- Identification numbers of instruments used
- Results of calibrations and field measurements
- Documentation of sampling activities
- Decontamination episodes
- Reference to other field logbooks or forms that contain specific information
- Discussion of problems encountered and the resolutions of those problems
- Discussion of deviations from the provisions of the FSP, the QAPP, or other governing documents
- Descriptions of all photographs taken

Personnel who maintain logbooks will conform to the following general guidelines for maintaining field logbooks:

- Documentation will be completed in permanent black ink
- All entries will be legible
- All pages will be consecutively numbered
- Errors will be corrected by crossing out with a single line and dating and initialing the lineout

A5 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The seven-step DQO process, described in EPA QA/G-4 (1994d), was used in developing quality objectives for this project, as presented in Sections A1 and A3. The specific quality objectives and criteria for measurement data, as they apply to this project, are also discussed in the following sections.

A5.1 PROJECT SCOPE AND ENVIRONMENTAL MEDIA

Groundwater samples will be collected from selected monitoring wells in Parcels C and D (Table 4-4 of the FSP). Samples from each site will be analyzed for the following analytes of concern: low-level CLP VOCs; low-level CLP SVOCs; low-level CLP pesticides and PCBs; CLP dissolved metals; TPH-e; TPH-p; hexavalent chromium; and MNA parameters. MNA parameters include reduced metals Fe2+ and Fe3+, nitrate, nitrite, sulfate, dissolved oxygen, oxidation-reduction potential, chloride, carbonate, calcium, magnesium, sodium, potassium, and TDS. The analytical suite for each monitoring well is identified in Table 4-4 of the FSP; the corresponding groundwater monitoring schedule is presented in Table 8-1 of the FSP.

For all wells, water level measurements will be made at each sampling event. In-situ measurement of groundwater parameters, including dissolved oxygen, oxygen-reduction potential, pH, temperature, specific conductivity, and reduced metals Fe2+ will be taken during groundwater sampling. Investigation-derived waste (IDW) will be handled according to the procedures outlined in Section 4.8 of the accompanying FSP.

A5.2 INTENDED DATA USERS AND USES

Data users include stakeholders, such as the regulatory agencies, the Navy, subcontractors to the Navy, and the public. Definitive data, as outlined below, will be required to allow comparison with drinking water standards, ambient levels and toxicity criteria for aquatic receptors and for further fate-and-transport studies.

A5.3 DATA TYPE AND QUANTITY

The data obtained from laboratory analysis can best be categorized as definitive. Definitive data are described in detail in the following subsection to establish that the data collected during this investigation will be of sufficient quality and quantity to meet the stated DQOs.

Definitive Data

Definitive data will be generated off site. The subcontracted laboratory will use methodologies approved by EPA for which it has been certified by the California Department of Health Services (DHS) through the Environmental Laboratory Accreditation Program (ELAP) and approved by the Navy. Definitive data will be obtained through the analysis of groundwater samples. QA/QC elements required for definitive data are:

- Sample documentation (location, date and time collected, and batch)
- Chain-of-custody forms
- Sampling design
- Initial and continuing calibration
- Determination and documentation of detection limits
- Analyte identification
- Analyte qualification
- QC blanks (trip, method, and rinsate)
- Matrix spike (MS) recoveries
- Performance evaluation (PE) samples

- Matrix duplicates or determination of analytical error
- Field duplicates or determination of total measurement error

Matrix duplicate samples measure the precision of an analytical method. Field duplicates provide an assessment of the overall precision of the measurement system, from sample acquisition through analysis. The variance, mean, coefficient of variation, and relative percent difference (RPD) will be calculated for the matrix under investigation.

One set of double-blind PE water samples supplied by Environmental Resource Associates (ERA) will be submitted to Severn-Trent Laboratories during the sampling event for VOCs, metals, TPH-e, anions, alkalinity, and TDS analysis. In addition, one set of single-blind PE water samples supplied by Environmental Resource Associates (ERA) will be submitted to Curtis and Tompkins Laboratories during the sampling event for hexavalent chromium analysis. The PE sample results will undergo cursory data validation by an independent, third-party contractor. The validated results will be evaluated using EPA guidelines as well as statistically-derived acceptance criteria provided by ERA. The results of the PE sample analyses will be used to evaluate the data quality of the project.

QC samples are collected in addition to field samples and are used in conjunction with laboratory QC samples to evaluate the quality of the data produced from the field sampling program. QC samples serve DQOs by meeting the established acceptance criteria specified in this QAPP and in each analytical method. Results for QC samples that do not meet the criteria may serve as indicators of unacceptable data, and obtaining such results may cause the laboratory to implement corrective action procedures or to qualify the data. The specific requirements for field and laboratory QC are provided in Section B6 of this QAPP.

A5.4 ACCEPTABLE LEVEL OF CONFIDENCE IN THE DATA

Determining acceptable limits on decision errors (DQO Step 6) will limit the uncertainty in the data set obtained through this project. Step 6 of the DQO process examines the acceptable limits on decision errors. The limits are needed to define the uncertainty that will be acceptable to project stakeholders.

The quality of the laboratory analytical data will be assessed in terms of PARCC, as discussed in detail in Section A5.5 of this QAPP. Further, professional judgment will be applied to determine the practical versus the statistical significance of the data collected (EPA 1998, 1999b). Decision errors resulting from sample design and data interpretation will be minimized through multiple internal and external reviews of project data and conclusions.

A5.5 SPECIFYING PERFORMANCE CRITERIA: PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS, AND COMPARABILITY PARAMETERS

All analytical results will be assessed according to the PARCC parameters described in the following sections. Precision and accuracy goals for each analytical method are presented in Appendix 3 in this QAPP.

A5.5.1 Precision

Precision is the degree of mutual agreement between individual measurements of the same property under prescribed similar conditions. Data precision is affected by field sampling precision and laboratory analytical precision. Data precision will be evaluated by collecting and analyzing field duplicates at a frequency of 10 percent of total samples collected, while laboratory analytical precision will be evaluated by analyzing matrix spike/matrix spike duplicates (MS/MSD) at a frequency of 5 percent of total samples collected. The results of duplicate analyses will be used to calculate the RPD used for evaluating precision.

The RPD is calculated by the following formula:

$$RPD = \frac{|A-B|}{(A+B)/2} \times 100\%$$

where:

A	=	First duplicate concentration
B	=	Second duplicate concentration

Four factors can impair the precision of duplicate data: (1) matrix interference, (2) laboratory imprecision, (3) sample heterogeneity, and (4) the nature of the RPD calculation. Constituents present in the field sample may interfere with accurate quantification of the target analytes. Laboratory imprecision is a result of inconsistency in preparing and analyzing the samples. In cases in which the duplicate samples contain extremely high or extremely low concentrations of the target analyte, the RPD calculation may indicate high variances that do not reflect analytical precision. The data will be qualified as estimated in cases in which the laboratory duplicates do not meet acceptance criteria and in which matrix interference or laboratory imprecision is determined to be the cause of such extremely high or low results.

The control limits for precision of field duplicates are set at 25 percent RPD for water samples. The control limits for precision of matrix spike and matrix spike duplicates are set at the RPD specified in Appendix 3. The control limits are selected through professional judgment and are intended as guidelines for laboratory precision.

A5.5.2 Accuracy

Accuracy is the degree of agreement between an analytical measurement and a reference accepted as a true value. The accuracy of a measurement system is affected by errors introduced through the sampling process by field contamination and sample preservation and sample handling procedures. Other factors that may affect accuracy are sample matrix, sample preparation, and analytical techniques. Sampling accuracy will be evaluated on the basis of the results of the analysis of field blanks, trip blanks, and source water blanks. To evaluate laboratory accuracy, the laboratory will conduct a program of sample spiking. The program includes analysis of the MS and MSD samples, laboratory control spikes (LCS) or blank spikes, surrogate standards, internal standards, and method blanks. MS and MSD samples are prepared and analyzed at a frequency of 5 percent; LCS or blank spikes are analyzed at a frequency of 5 percent; and surrogate standards and internal standards, when applicable, are added to every sample analyzed. The results of analysis of the spiked samples are used to calculate the percent recovery for evaluating accuracy.

Percent recovery is calculated by the following formula:

$$\text{Percent Recovery} = \frac{S - C}{T} \times 100\%$$

where:

S	=	Measured spiked sample concentration
C	=	Sample concentration
T	=	True or actual concentration of the spike

Results that fall outside the acceptance range specified in Appendix 3 of this QAPP will be evaluated further.

A5.5.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in parameters at a sampling point, or an environmental condition that they are intended to represent. Representativeness of data will be ensured through the consistent application of established field and laboratory procedures. To aid in the evaluation of the representativeness of the sample, field and laboratory blank samples and background samples will be evaluated for the presence of contaminants. Data determined by comparison with the existing data to be nonrepresentative will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

A5.5.4 Completeness

Completeness is a measure of the percentage of project-specific data that are usable and valid. Valid data are obtained when samples are collected and analyzed in accordance with the QC procedures outlined in this QAPP, and when none of the QC criteria that affect data usability is exceeded. Other factors unrelated to the validity of the data can affect completeness, such as lost or broken samples. The project completeness value will be calculated when sampling has been completely finished and all data have been validated. Completeness will be calculated by dividing the number of usable sample results by the total number of planned sample results for this source removal project. The completeness goal for this project is 90 percent.

A5.5.5 Comparability

The comparability objective determines whether analytical conditions are sufficiently uniform for each analytical run to ensure that all reported data will be consistent. Comparability is ensured by using similar analytical methods from one investigation to the next. Analytical techniques that will be used for this field investigation are comparable to techniques used in previous investigations at HPS.

A5.6 DETECTION AND QUANTITATION LIMITS

Tables of detection limits for analytes specified for the project are included in Appendix 2 of this QAPP. The instrument detection limit (IDL) is the minimum concentration of an analyte that can be distinguished from the normal electronic noise of an analytical instrument. The quantitation limit represents the lowest concentration at which an analyte can be accurately and reproducibly quantified. Contract-required detection limits (CRDL) and contract-required quantitation limits (CRQL) are the minimums that are contractually required for analyses performed by CLP contractors.

For this project, samples analyzed for metals as prescribed in the CLP statement of work for inorganic analytes (EPA 1995a) will be reported as estimated values if concentrations are less than CRDLs, but greater than instrument detection limits. Samples analyzed for organics as prescribed in the CLP statement of work for organic analytes (EPA 1994c) will be reported as estimated values if concentrations are less than the CRQLs, but greater than the MDL. The IDL for each inorganic analyte will be given as the detection limit in the laboratory's electronic data deliverable (EDD); otherwise, the statistical evaluations may be biased by high-value non-detect results if the CRDL or CRQL is reported as the detection limit.

A6 DOCUMENTATION AND RECORDS

Documentation is critical for evaluating the success of any activity. The following sections discuss the requirements of laboratories for preparing definitive data packages. The electronic data delivered to the Navy at the conclusion of each sampling event is to be in a format compatible with the Navy Environmental Data Transfer Standard (NEDTS).

A6.1 SUMMARY DATA PACKAGE

The CLP and CLP-type summary data packages will be required for all analyses and will contain sample results (Form I) and all QA/QC summary forms (forms II through X for organic compounds and forms II through XIV for inorganic compounds) for all samples in a given sample delivery group (SDG). Form I will include all sample results, corrected for dilution, as appropriate. If the TtEMI sample identification (ID) has been truncated because of software limitations, the complete sample ID will appear on Form I, either in the comments section or hand-printed after the truncated ID.

An SDG is a group of 20 or fewer samples for the same project received within a period of 14 or fewer days. An SDG is primarily a reporting format and is not limited to sample receipt groups, preparation batches, or analytical batches. The SDG name will be a unique number that is not an actual sample ID or a part of an actual sample ID. Data for all samples in the SDG will be submitted concurrently. Partial submittals are unacceptable. The subcontracted laboratory will provide TtEMI with two copies of the summary data package within 35 days after receiving the last sample in the SDG. That package will be part of the standard analytical service.

The subcontracted laboratory will prepare summary data packages, in accordance with instructions provided in Section II.D, Exhibit B, in the CLP statements of work for organic analysis and inorganic analysis (EPA 1994c, 1995a). The summary data package will consist of a case narrative, copies of all associated chain-of-custody forms, sample results, and QA/QC summaries. The case narrative will include the following information:

- Subcontractor name, project name, CTO (project) number, project order number, SDG number, and a table that cross-references TtEMI and laboratory sample IDs
- Detailed documentation of all sample shipping and receiving, preparation, analytical, and quality deficiencies, including analyses performed without a standard certified by the American Association for Laboratory Accreditation
- Thorough explanation of all cases of manual integration
- Copies of all associated nonconformance and corrective action forms that describe the nature of the deficiency and the corrective action taken
- Copies of all associated sample receipt notices

A6.1.1 Organic Analysis

The following outline describes the format of the summary data package for organic analysis:

<u>Section I</u> **Case Narrative**

1. Case narrative
2. Copies of nonconformance and corrective action forms
3. Chain-of-custody forms
4. Copies of sample receipt notices
5. Internal tracking documents, as applicable

<u>Section II</u> **Sample Results -** Form I for the following:

1. Environmental samples, including dilutions and reanalyses
2. Tentatively identified compounds (TIC) (SVOC and VOC analyses only)

<u>Section III</u> **QA/QC Summaries -** Forms II through VIII for the following:

1. System-monitoring compound and surrogate recoveries (Form II)
2. MS and MSD recoveries and RPDs (Forms I and III)
3. Blank spike or LCS recoveries (Forms I and III-Z)
4. Method blanks (Forms I and IV)
5. Performance check (Form V)
6. Initial calibrations, with retention time information (Form VI)
7. Continuing calibrations, with retention time information (Form VII)

8. Quantitation limit standard (Form VII-Z)
9. Internal standard areas and retention times (Form VIII)
10. Analytical sequence (forms VIII-D and VIII-Z)
11. Gel-permeation chromatography calibration (Form IX)
12. Single component analyte identification (Form X)
13. Multicomponent analyte identification (Form X-Z)
14. Matrix-specific method detection limit (Form XI-Z)

A6.1.2 Inorganic Analysis

The following outline describes the format of the summary data package for inorganic analysis:

Section I **Case Narrative**

1. Case narrative
2. Copies of nonconformance and corrective action forms
3. Chain-of-custody forms
4. Copies of sample receipt notices
5. Internal tracking documents, as applicable

Section II **Sample Results -** Form I for the following:

1. Environmental samples (including dilutions and reanalyses)

Section III **QA/QC Summaries -** Forms II through XIV for the following:

1. Initial and continuing calibration verifications (Form II)
2. CRDL standard (Form II)
3. Detection limit standard (Form II-Z)
4. Method blanks, continuing calibration blanks, and preparation blanks (Form III)
5. Inductively coupled plasma (ICP) interference check samples (Form IV)
6. MS and post-digestion spikes (forms V and V-Z)
7. Sample duplicates (Form VI)
8. LCSs (Form VII)
9. Method of standard additions (Form VIII)
10. ICP serial dilution (Form IX)
11. IDLs (Form X)
12. ICP inter-element correction factors (Form XI)
13. ICP linear working range (Form XII)

A6.2 FULL DATA PACKAGE (CONTRACT LABORATORY PROGRAM AND CONTRACT LABORATORY PROGRAM-TYPE)

Full data packages will contain all the information from the summary data package and all associated raw data for samples in a given SDG. The subcontracted laboratory will provide the full data package to TtEMI within 35 days after receiving the last sample in the SDG. Unless otherwise requested, the subcontracted laboratory will deliver one copy of the full data package; no more than two copies will be requested. For ease of use, the full data packages will be separated by analysis and should not be bound. The full data package will consist of a case narrative, copies of all associated chain-of-custody records, sample results, QA/QC summaries, and all associated raw data.

A6.2.1 Organic Analysis

The following outline describes the format of the full data package for organic analysis:

<u>Sections I, II, and III</u> **Summary Package**

<u>Section IV</u> **Sample Raw Data -** Indicated form, plus all associated raw data

1. Analytical results, including dilutions and reanalyses (Forms I and X)
2. TICs (Form I —SVOC and VOC analysis only)

<u>Section V</u> **QC Raw Data -** Indicated form, plus all associated raw data

1. Method blanks (Form I)
2. MS and MSD samples (Form I)
3. Blank spikes or LCSs (Form I)

<u>Section VI</u> **Standard Raw Data -** Indicated form, plus all associated raw data

1. Performance check (Form V)
2. Initial calibrations, with retention time information (Form VI)
3. Continuing calibrations, with retention time information (Form VII)
4. Quantitation limit standard (Form VII-Z)
5. Gel-permeation chromatography calibration (Form IX)

<u>Section VII</u> **Other Raw Data**

1. Percent moisture for soil samples
2. Sample extraction and cleanup logs
3. Instrument analysis log for each instrument used (Form VIII-Z)
4. Standard preparation logs, including initial and final concentrations for each standard used
5. Formula and a sample calculation for the initial calibration
6. Formula and a sample calculation for water and soil sample results

A6.2.2 Inorganic Analysis

The following outline describes the format of the full data package for inorganic analysis:

Sections I, II, III **Summary Package**

Section IV **Instrument Raw Data -** Sequential measurement readout records for ICP, graphite furnace atomic absorption, flame atomic absorption, cold vapor mercury, cyanide, and other inorganic analyses, which will contain the following information:

1. Environmental samples, including dilutions and reanalysis
2. Initial calibration
3. Initial and continuing calibration verifications
4. Detection limit standards
5. Method blanks, continuing calibration blanks, and preparation blanks
6. ICP interference check samples
7. MS and post-digestion spikes
8. Sample duplicates
9. LCSs
10. Method of standard additions
11. ICP serial dilution

Section V **Other Raw Data**

1. Percent moisture for soil samples
2. Sample digestion, distillation, and preparation logs, as necessary
3. Instrument analysis log for each instrument used
4. Standard preparation logs, including initial and final concentrations for each standard used
5. Formula and a sample calculation for the initial calibration
6. Formula and a sample calculation for water and soil sample results

A6.3 DATA PACKAGE FORMAT

Electronic data deliverables (EDD) are required for all HPS analytical results. An automated laboratory information management system (LIMS) must be used to produce the EDD. Manual creation of the deliverable (data entry by hand) is unacceptable. The laboratory will verify EDDs internally before they are issued. The EDD will correspond exactly to the hardcopy data. No duplicate data will be submitted.

Results that should be included in all EDDs are:

- Target analyte results for each sample and associated analytical methods requested on the chain-of-custody form
- TIC results reported for SVOC and VOC analyses
- Method and instrument blanks and preparation and calibration blank results reported for the SDG
- Percent recoveries for the spike compounds in the MSs, MSDs, blank spikes, or LCSs
- Matrix duplicate results reported for the SDG form
- All reanalyses, reextractions, or dilutions reported for the SDG, including those associated with samples and the specified laboratory QC samples.

Data Storage and Disposal

Electronic and hardcopy data must be retained for a minimum of 3 and 10 years, respectively, after final data have been submitted. The subcontracted laboratory will use a magnetic tape storage device or other similar storage device that is capable of recording data for long-term, off-line storage. Raw data will be retained on magnetic tape.

A6.4 DATA ARCHIVING AND RETRIEVAL

Field and analytical data collected for this project and other environmental investigations are critical to all site characterization efforts, development of comprehensive conceptual models, risk assessments, and the selection of remedial actions to protect human health and the environment. An information management system is needed to ensure efficient access to the data so that the goals of real-time and on-site decision making can be achieved. Data collected during this investigation will be loaded into TtEMI's relational database.

A6.4.1 Data Management Scheme

To satisfy long-term data management goals, the data will be loaded into the database system at TtEMI for storage, further manipulation, and retrieval after review and validation of laboratory and field reports. The database will be used to provide data for chemical and hydrogeologic analysis and for preparing reports and graphic representations of the data. Additional data acquired from field activities will be recorded on field forms (see Appendix 1 of this QAPP). The forms will be reviewed for completeness and accuracy by the project chemist or geologist. Data from field forms and related chain-of-custody forms will be recorded in the database, as appropriate. The data will be submitted to SWDIV in a format compatible with NEDTS. Hard copies of forms, data, and chain-of-custody forms will be filed in a secure storage area, according to project and document control numbers. Laboratory data packages and reports will be archived for a minimum of 10 years.

A6.4.2 Data Management Strategy

Short- and mid-term strategies for data management require that the HPS data set be updated monthly. The data consist of chemical and field data from the Navy, TtEMI, other Navy contractors, and other sources, such as regulatory agencies. Previous HPS data have been converted from FoxPro into an Oracle database, which can generate reports using available computer-aided drafting and design, contouring, and GIS software.

B1 MEASUREMENT AND DATA ACQUISITION

This section describes requirements for the following:

- Sampling process design (Section B2)
- Sampling method (Section B3)
- Collection, handling, and analysis of samples (Sections B4 and B5)
- QC samples and procedures (Section B6)
- Calibration and maintenance of instruments (Section B7)
- Analytical supplies and miscellaneous equipment (Section B8)

This section provides sufficient detail to evaluate whether the methods used for this project have been verified and documented.

B2 SAMPLING DESIGN (EXPERIMENTAL DESIGN)

Detailed information about the types of samples required, sampling frequencies, and sample design is presented in Sections A1 and A3. A summary of the number of samples to be collected and the analyses required for each sample can be found in Tables 4-4 and 4-5 of the accompanying FSP. The analytical methods that will be used to analyze samples are presented in Appendix 2 of this QAPP. Sampling and analysis will be conducted in accordance with the provisions of this document, the FSP, and the basewide HSP.

B3 SAMPLING METHODS

This discussion describes the procedures for collecting samples and includes:

- Identification of all sampling methods to be used
- Implementation requirements
- Decontamination procedures
- Materials required

B3.1 SAMPLE COLLECTION AND DECONTAMINATION

Samples will be collected in accordance with SOP No.10, Revision No. 3 (presented in Appendix C of the accompanying FSP), as amended in Section 4.3.3 of the accompanying FSP.

As described in detail in Section 4.7 of the FSP, sampling tools will be decontaminated according to the procedures specified in General Equipment Decontamination SOP No. 002, Revision No. 2 (presented in Appendix C of the accompanying FSP). Decontamination fluids and other IDW will be placed in containers and disposed of as described in Section 4.8 of the FSP.

B3.2 SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

The analytical methods, type of sample container to be used for each analysis, sample volumes required, preservation requirements for all samples, and maximum holding times for sample extraction and analysis are presented in Appendix 2 of this QAPP.

B4 SAMPLE HANDLING, CUSTODY, AND SHIPPING PROCEDURES

Documentation and records, including field forms and field logbooks, are discussed in Section A4.4 of this QAPP. The sample handling and custody requirements for samples collected at HPS are discussed in the following sections. The sections describe documentation of sample custody and handling procedures to be followed while in the field, while transporting the samples to the laboratory, and at the laboratory.

B4.1 SAMPLE CUSTODY PROCEDURES

Documentation during sampling activities is essential to ensure proper sample identification. Standard sample custody procedures will be used to maintain and document sample integrity during collection, transportation, storage, and analysis. Sample custody documents must be written in indelible ink. The documents will be corrected by drawing one line through the incorrect entry, entering the correct information, and initialing and dating the correction. A sample is considered to be in custody if one of the following statements applies:

- It is in a person’s physical possession or view
- It is in a secure area to which access is restricted
- It is placed in a container and secured with an official custody seal, so that the sample cannot be reached without breaking the seal

Samples and documentation must be maintained in the custody of authorized personnel or in a secure area. The field team leader is responsible for proper sample handling and documentation, so that the possession and handling of individual samples can be traced from the time of collection to the time of receipt by the laboratory. The laboratory's QA manager is responsible for establishing a sample control system that will allow sample possession to be traced from receipt by the laboratory to disposition of the final sample.

B4.1.1 Sample Labels

A sample label will be affixed to all sample containers sent to the laboratory. The identification label will be completed with the following information, written in indelible ink:

- Sample ID number
- Date and time of sample collection
- Project name
- Sample collector's initials
- Preservative used (if applicable)
- Filtering (if applicable)
- Analysis required

After labeling, each sample will be refrigerated or placed in a cooler containing ice to maintain the sample temperature at approximately 4 ºC.

B4.1.2 Custody Seals

Custody seals will be used on each sample transport container to ensure that no tampering occurs. Custody seals used during the project will consist of security tape bearing the date and initials of the sampler or field team leader. Sample transport containers will be sealed in that manner immediately after the samples are packaged. The tape will be placed so that the seal must be broken to gain access to the contents of the transport container.

B4.1.3 Chain-of-Custody Records

Chain-of-custody procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field until they are accepted at the laboratory. The chain-of-custody record will also be used as documentation of the samples collected and the analysis requested. Appendix 1 to this QAPP provides an example of a chain-of-custody record used by TtEMI. Laboratory-specific chain-of-custody records may also be used, depending on the site investigation. The field personnel will record the following information on the chain-of-custody record:

- Project name and number
- Name and signature of sampler
- Destination of samples (laboratory name)
- Sample ID number(s)
- Sample location, description, and depth, when applicable
- Date and time of collection
- Number and types of containers filled
- Analysis requested
- Preservatives used
- Filtering (if applicable)
- Signatures of individuals involved in custody transfer (including date and time of transfer)
- Laboratory purchase order number
- Airbill number (if applicable)
- Relevant remarks related to sample analysis (such as samples selected for MS/MSD analysis)

Unused lines on the chain-of-custody record will be crossed out and initialed. Chain-of-custody records initiated in the field will be signed by the field personnel, the airbill number will be recorded, and the record will be placed in a plastic bag and taped to the inside of the lid of the shipping container used for sample transport. Copies of the chain-of-custody record and the airbill will be retained and filed by field personnel. A copy of the chain-of-custody record will be delivered to the sample tracking coordinator as soon as possible after sampling.

B4.1.4 Shipping Procedures

Samples collected during the field effort must be identified as environmental samples. Environmental samples are defined as samples of soil, groundwater, or other matrices that are not saturated or mixed with product material. U.S. Department of Transportation (DOT) regulations will be followed during packaging and shipment of samples. The following procedures meet those requirements and are explained in EPA guidance on field operations methods (EPA 1987):

- The cooler will be filled with sample bottles and packing material. Sufficient packing material will be used to prevent sample containers from making contact with another during shipment. Blue ice or wet ice will be added to maintain the sample temperature at approximately 4 °C during shipment.
- The chain-of-custody records will be placed inside a plastic bag. The bag will be sealed and taped to the inside of the cooler lid. The FedEx airbill, if required, will be completed before the samples are transferred to the carrier. The laboratory will be notified if the sampler suspects that the sample contains any substance that would require that laboratory personnel take safety precautions.
- The cooler will be closed and taped shut with strapping tape around both ends. If the cooler has a drain, the drain will be taped shut on both the inside and the outside of the cooler.
- Two signed custody seals will be placed on the cooler (one on the front and one on the back). Wide clear tape will be placed over the seals to prevent accidental breakage.
- The chain-of-custody record will be transported inside the sealed cooler. When the analytical laboratory receives the cooler, laboratory personnel will open it and sign the chain-of-custody record to document the transfer of the samples.

Samples may be held on site for more than 3 days during weekend field activities if there is no possibility that analytical holding times will be exceeded. Samples collected during the weekend will be stored under refrigeration and shipped on the following Monday. Samples for analytes that have extremely short holding times, such as 24 hours, will be shipped on the day of sampling.

B4.1.5 Cooler Receipt

Upon receiving a cooler, laboratory personnel will review the contents, sign the chain-of-custody form and airbill, and retain both documents for their records. The following information will be recorded on the chain-of-custody record or another appropriate document at the time of sample receipt:

- Status of the custody seals
- Temperature of the cooler
- ID number of any broken sample containers
- Description of discrepancies in the chain-of-custody records, sample labels, and requested analyses
- Observations of visible headspace in vials destined for VOC analysis, indicating inadequate sample collection
- The pH of water samples received (the pH of VOC water samples will be documented at the time of analysis)
- Storage location of the sample and sample extracts

Laboratory personnel will contact the project chemist about discrepancies in paperwork and sample preservation. Nonconformance and corrective actions should be documented in accordance with laboratory SOPs. Those procedures will be available on file at the laboratory. After samples have been accepted, checked, and logged in, the laboratory must maintain them in a manner consistent with the custody and security requirements specified in the laboratory QA plan.

Samples and sample extracts will be assigned to a specific refrigerator within the laboratory. VOC samples will be maintained in a separate refrigerator in an organic-free atmosphere. All laboratory refrigerators will be assigned numbers, and the refrigerator number will be recorded on a document that references the sample and extract locations. Only laboratory personnel will have access to the samples, and they will be required to sign a log sheet when removing samples and extracts from the refrigerators or replacing them. The log sheets will provide a chain-of-custody record as the sample is moved to various locations within the laboratory. A chain-of-custody record, similar to the record used for sampling procedures, will be completed for samples removed from the laboratory for disposal or other purposes.

B5 ANALYTICAL METHODS

Appendix 2 of this QAPP presents analytical methods that will be used to analyze samples collected under the HPS Phase I GDGI. The analytical methods were selected to provide data of the necessary quality to meet the DQOs for this project and to maintain the consistency and comparability of data. The data collected under the current groundwater monitoring program must be comparable to previously collected HPS groundwater data to allow evaluation of decisions identified through the DQO process

(Section A1.4). To promote comparability of data with previous analytical results, CLP methods were chosen for the majority of analyses. Analytical methods and corresponding detection and reporting limits are presented in Appendix 2. CLP methods will be used for all analyses except that for TPH, which will be analyzed for by EPA SW846 (EPA 1995b) Method 8015B. Low-level CLP methods will be used for VOCs, SVOCs, and PCBs to meet detection limits required for comparison with identified screening criteria (Table 2-2 in Appendix 2 of this QAPP). Any modifications of the analytical methods presented in Appendix 2 will be submitted to the Navy and regulatory agencies for review before use. A subcontract laboratory using methodologies approved by EPA for which it has been certified by the California DHS through ELAP and approved by the Navy will analyze the samples.

The laboratory analytical, data reporting, and validation procedures will be carried out in accordance with the provisions of the Navy Installation Restoration Chemical Data Quality Manual (Naval Facilities Engineering Service Center [NFESC] 1999) and the protocols documented in this QAPP. A minimum of 20 percent of all analytical data received from the laboratory will be subjected to full validation, as described in Section D1.2.3.3; the remaining 80 percent will undergo cursory validation, as described in Section D1.2.3.2. Subcontracted laboratories will retain a staff that possesses analytical expertise in (1) organic and inorganic analyses, (2) QA/QC procedures, (3) production of CLP and CLP-type data packages, and (4) operation and maintenance of the LIMS. The laboratory will have sufficient qualified personnel and appropriate analytical instruments available to technically and contractually carry out work required for the HPS Phase I GDGI. The contract-required quantitation and detection limits for the methods are listed in Appendix 2 of this QAPP.

Field measurements will be made by use of methods identical to those used in conducting previous events. In-situ measurements of groundwater parameters (Table 2-1, Appendix 2 of this QAPP) will be collected with a high-precision water quality meter connected to a flowcell and down-well pump, as detailed in Section 4.3.3 of the accompanying FSP.

B6 QUALITY CONTROL

The primary functions of a sampling and analysis program are to obtain accurate, representative environmental samples and to provide defensible analytical data. A program for evaluating field and laboratory data was developed to achieve those goals. The quality of the field data will be assessed through the regularly scheduled collection and analysis of field QC samples. Laboratory QC samples will also be analyzed in accordance with referenced analytical method protocols to ensure that laboratory procedures and analyses are conducted properly.

The following subsections discuss the types of QC samples to be collected and analyzed for this project and their role in the assurance that project data are acceptable. Additional QC procedures are not limited to those discussed in this section. Field and laboratory personnel may implement additional procedures in accordance with specific method protocols. The following subsections discuss field QC samples, field measurement QC procedures, laboratory QC samples, and laboratory QC procedures.

B6.1 FIELD QUALITY CONTROL SAMPLES

QC samples are collected in the field and used to evaluate the validity of the field sampling effort. Field QC samples are collected for laboratory analysis to check sampling and analytical precision, accuracy, and representativeness. The following section discusses the types and purposes of field QC samples that will be collected for this project. Table B-1 provides a summary of the types and frequency of collection of field-collected QC samples.

TABLE B-1

FIELD-COLLECTED QUALITY CONTROL SAMPLES

Sample Type	Frequency of Analysis
Field duplicate	10 percent
MS/MSD	5 percent[a]
Source water blank	One per source per event, per source water type, for all analytes, as necessary[b,c]
Equipment rinsate blanks	One per day (per parameter)
Trip blank	One per transport container containing groundwater samples for VOC analysis

Notes:

a MS and MSD sample pairs for water samples will be included with each analytical batch. Matrix duplicates replace MSDs for inorganic analysis.

b A sampling event is defined as a period of time during which sampling activities occur. Sampling followed by an extended absence, with a subsequent return to the site to perform additional sampling (between quarterly sampling rounds, for example), would constitute two events.

c Both single-use, disposable sampling equipment and sampling equipment that requires decontamination (for example, multiple-use stainless steel bailers), may be used. Source water blanks are not required when disposable equipment is used.

B6.1.1 Field Duplicates

Field duplicate samples are two samples collected at the same time and from the same source that are submitted as separate samples to one laboratory for analysis. Field duplicates are used to evaluate the consistency of the overall sampling and analytical system.

Field duplicates are collected at a frequency of 10 percent. Field duplicates are analyzed for the same parameters as the field samples collected during the event. Duplicates will be sampled from locations that have the greatest potential for contamination. The samples will be collected, numbered, packaged, and sealed in the same manner as other samples. They will be submitted blind to the laboratory.

Results of the analysis of field duplicates are used to evaluate precision by calculating the RPD. Limits for precision are set at 25 percent for water matrices.

B6.1.2 Source Water Blanks

Source water blanks are used to evaluate the quality of the water used for the last rinse of the decontamination process. The purpose of the source water blank is to confirm that no contamination that originated in the rinse water was added to the sampling tools. The source water blank consists of deionized water used for the final rinse and is analyzed for the same analytical suite as the samples taken with equipment decontaminated with that water. Both single-use, disposable sampling equipment and sampling equipment that requires decontamination (for example, multiple-use stainless steel bailers) can be used to collect groundwater samples. Collection of source water blanks is not required when disposable equipment is used. When reusable equipment is used, source water blanks can be collected at a frequency of one per sampling event, per type of source water used for the final decontamination rinse, as necessary. Multiple containers of the same brand of deionized or distilled water are considered the same source.

B6.1.3 Trip Blanks

A trip blank demonstrates that contamination is not originating from sample containers or from any factor arising during the transport of samples. A trip blank originates at the laboratory as a 40-milliliter (mL) vial typically used for VOC analysis. The vial is filled at the laboratory with reagent-grade, organic-free water. The trip blank is then transported to the site with the empty containers that are to be used for sample collection. Trip blanks are stored at the site until the proposed field samples have been collected. One trip blank will accompany each sample transport container containing water samples for

CLP-VOC analysis to the laboratory for analysis. The trip blank is not opened until it has been returned to the laboratory at the time of analysis. Trip blanks are analyzed only for low-level CLP-VOCs.

B6.1.4 Equipment Rinsate Blanks

The collection of equipment rinsate samples demonstrates whether the decontamination procedure for reusable sampling equipment is effective in removing contaminants from field equipment used to collect samples. An equipment rinsate is a blank sample collected after a sampling device has undergone standard decontamination procedures. Appropriate water for the intended analysis will be poured over or through the decontaminated sampling equipment, reserved in an appropriate sample container, and sent to the laboratory for analysis.

The collection of equipment blank samples can also demonstrate whether disposable sampling equipment is free from contamination before it is used. Appropriate water for the intended analysis will be poured over or through the sampling equipment, reserved in an appropriate sample container, and sent to the laboratory for analysis.

The frequency of collection of equipment rinsate blank samples is presented in Table B-1 (page B-8 of this QAPP) and in Table 4-4 of the FSP. Equipment rinsate blanks will be analyzed for the same parameters as the field samples collected. During the data validation process, the results of analysis of the equipment rinsate blanks will be used to qualify data or to evaluate the levels of analytes in the field samples.

B6.2 QUALITY CONTROL PROCEDURES FOR FIELD MEASUREMENTS

Field measurements of dissolved oxygen, oxygen-reduction potential, pH, temperature, and specific conductivity will be taken during groundwater sampling of the monitoring wells. TtEMI has implemented the following internal QC procedures to assess the quality of field measurements:

- Consistent use of SOPs
- Documentation of sampling procedures
- Documentation of field work
- Identification and correction of nonconformance situations through audit systems
- Communication with Navy personnel about field procedures and work schedules

Water level measurements will also be made in the field; measurements will be made in accordance with TtEMI SOP 014, Revision No. 0 (Appendix C of the accompanying FSP).

B6.3 LABORATORY QUALITY CONTROL SAMPLES

Laboratory QC samples are analyzed to evaluate the quality of preparation and analysis of field samples. Laboratory QC samples are prepared and analyzed at the laboratory to assess analytical precision, accuracy, and representativeness. The types of laboratory QC samples that will be used are discussed in the following sections.

B6.3.1 Method Blanks

Method blanks are prepared to determine whether contamination of the field sample is occurring in the laboratory during sample preparation or analysis. A method blank consists of laboratory organic-free water and is prepared and analyzed by the same methods and procedures and for the same parameters as those for the field samples. Method blanks are prepared at the frequency prescribed in the individual method.

B6.3.2 Laboratory Control Samples or Blank Spikes

An LCS or blank spike originates in the laboratory as deionized or distilled water that has been spiked with standard reference materials of known concentration. An LCS or blank spike is analyzed to verify the accuracy of the analytical system. LCSs and blank spikes are prepared and analyzed by the same procedures as those for field samples, at the frequency prescribed in the individual method. Appropriate CLP and laboratory-specific protocols will be followed to assess the usability of the data if LCS or blank spike percent recovery results used to determine accuracy or RPD results used to determine precision are outside established acceptance limits.

B6.3.3 Matrix Spike and Matrix Spike Duplicates

MS and MSD samples are analyzed to evaluate the suitability of an analytical method for a particular environmental sample matrix. A known concentration of target analytes added to an aliquot of the field sample used in preparing the MS sample. To minimize errors, the field samples will not be spiked in the field. Instead, samples will be spiked when they are prepared for analysis at the laboratory. MSs and MSDs measure the efficiency of all the steps of the analytical method in recovering target analytes from an environmental sample matrix. The percent recoveries will be calculated for each of the spiked analytes and used to evaluate analytical accuracy. The RPD between spiked samples will be calculated to evaluate precision. For inorganic analyses, a matrix duplicate is analyzed, rather than an MSD. Evaluation of precision is based on comparison of the results of duplicate and original analyses.

MS and MSD samples are analyzed at a frequency of 5 percent. An additional sample volume will be collected for MS and MSD for water samples. If the MS and MSD percent recoveries used to assess accuracy or the RPD results used to assess precision are outside the established acceptance limits, CLP and laboratory protocols specific to the method will be followed to evaluate the usability of the data. LCS or blank spikes, if available, will be examined to determine the effect of the out-of-control event on the reported results. Control limits for the evaluation of MS and MSD accuracy and precision are provided in Appendix 3 of this QAPP.

B6.3.4 Surrogate Standards

Surrogate standards consist of known concentrations of nontarget analytes that are added to each sample, method blank, LCS, and MS/MSD before preparation and analysis of samples for organic parameters. The surrogate standard measures the efficiency of the analytical method in recovering the target analytes from an environmental sample matrix.

Surrogate standards provide an indication of laboratory accuracy and matrix effects for every field and QC sample that is analyzed for volatile and extractable organic compounds. Surrogate compounds are used in the analysis of VOCs to monitor purge efficiency and analytical performance, while surrogates are used in the analysis of extractable organic compounds to monitor the extraction process and analytical performance.

Surrogate percent recoveries obtained from sample analysis are evaluated using CLP and laboratory control limits. Factors such as matrix interference and high concentrations of analytes may affect surrogate recoveries. The effects of the sample matrix are frequently outside the control of the laboratory and may present unique problems. Review and validation of data on the basis of specific sample results are frequently subjective and require analytical experience and the application of professional judgment.

Laboratory personnel are required to reextract (when applicable) and reanalyze samples when results for associated surrogates are outside control limits. Data from both analyses of the samples in question are reported. The data will be qualified during review. Data will be qualified as estimated for SVOC analysis if two or more surrogates from each fraction (base/neutral and acid) are outside the control limits. EPA guidelines for evaluating organic analysis provide additional evaluation criteria (EPA 1994a). Guidelines for surrogate recovery for this project are provided in Appendix 3 of this QAPP.

B6.3.5 Internal Standards

Internal standards are compounds that are added to every VOC and SVOC standard, method blank, LCS, MS/MSD, and sample or sample extract at a known concentration before instrument analysis. They are used as the basis for quantification of the target compounds. Application of internal standards ensures that sensitivity and response of the gas chromatograph (GC)/mass spectrometer are stable during every analytical run. An internal standard is used to evaluate the efficiency of the sample introduction process and serves to monitor the efficiency of the analytical procedure for each sample matrix encountered. Internal standards are also used in the analysis of organic compounds by GC to monitor changes in retention times. Validation of internal standards data will be based on EPA protocol presented in guidelines for evaluating organic analyses (EPA 1994a).

B6.4 LABORATORY CONTROL PROCEDURES

The laboratory will conform to the following QC procedures, in addition to analyzing laboratory QC samples, as described in Section B6.3.

B6.4.1 Method Detection Limit Studies

The MDL is a specified limit at which there is 99 percent confidence that the concentration of the analyte is greater than zero. The MDL takes into account sample matrix and preparation. The subcontracted laboratory will demonstrate the MDLs for all analyses, except inorganic analyses and physical properties test methods.

MDL studies will be conducted annually for soil and water matrices, or more frequently if any method or instrument is changed. Each MDL study will consist of seven replicates spiked with all target analytes of interest at concentrations no greater than required quantitation limits. The replicates will be extracted and analyzed in the same manner as routine samples. If a number of instruments are used, each will be included in the MDL study. The reported MDLs will be representative of the least-sensitive instrument. MDLs must meet the required quantitation limits. If all MDLs do not meet the required quantitation limits, the situation is considered out of control, and corrective action will be taken.

B6.4.2 Instrument Detection Limit Studies

The IDL is the minimum concentration of a compound that can be distinguished from background noise by an analytical instrument. The IDL is a measurement of instrument sensitivity and does not take into account sample matrix and preparation. The subcontracted laboratory will demonstrate the IDLs for the CLP inorganic analyses.

B6.4.3 Sample Quantitation Limits

Sample quantitation limits (SQL), also referred to as practical quantitation limits, are CRQLs (organic analytes) or CRDLs (inorganic analytes) adjusted for the characteristics of individual samples. The CRQL is a chemical-specific level that a laboratory should be able to detect routinely and quantitate for a given sample matrix. The CRQL or CRDL is usually defined in the analytical method or in project-specific documentation. The SQL takes into account changes in the preparation and analytical methodology that may alter the ability to detect an analyte, such as use of a smaller sample aliquot or dilution of the sample extract. Physical characteristics (such as sample matrix and percent moisture) that may alter the ability to detect the analyte are also considered. The laboratory will calculate and report SQLs for all environmental samples.

B6.4.4 Control Charts

Control charts document data quality in graphic form for such specific method parameters as surrogates and blank spike recoveries. A collection of data points for each parameter is used to statistically calculate means and control limits for a given analytical method. The information is useful in determining whether chemical measurement systems are in control. In addition, control charts provide information about trends over time in specific analytical and preparation methodologies. It is recommended that subcontract laboratories maintain control charts for organic and inorganic analyses. At a minimum, method-blank surrogate recoveries and blank spike recoveries should be charted for all organic methods. Blank spike recoveries should be charted for inorganic methodologies. Control charts should be updated monthly.

B7 TESTING, INSPECTION, AND MAINTENANCE OF INSTRUMENTS AND EQUIPMENT

The following sections discuss regularly scheduled preventive maintenance and calibration procedures that are used to keep all field and laboratory equipment in good working condition.

B7.1 MAINTENANCE OF FIELD EQUIPMENT

Detailed information about maintenance and servicing of field equipment is available in the instruction manual of the specific instrument to be used. Field personnel will record equipment maintenance information in field logbooks. Problems with instruments encountered during field work will be recorded and remedied in the field, if possible. Specific preventive maintenance procedures will follow the manufacturer's recommendations.

B7.2 CALIBRATION OF FIELD ANALYTICAL EQUIPMENT

Equipment used during field activities will be calibrated at the beginning of each day of sampling or as directed by the manufacturer or vendor. The frequency of calibration may depend on the type and stability of the equipment, the analytical methods employed, and the intended use of the equipment. More detailed calibration procedures for equipment are available from the manufacturer's instruction manual. All calibration information will be recorded in a field logbook or on field forms. A label specifying the scheduled date of the next calibration will be attached to the field equipment. If such identification is not feasible, calibration records for the equipment will be readily available for reference.

Should any of the field equipment become inoperable, it will be removed from service and tagged to indicate that repair, recalibration, or replacement is needed. The field team leaders will be notified so that prompt service can be completed or substitute equipment can be obtained. Any action of this type will be reported in the daily field QC report. Corrective action measures are discussed in Section C1.2 of this QAPP.

B7.3 MAINTENANCE OF LABORATORY EQUIPMENT

The subcontract laboratories will prepare and follow a maintenance schedule for each instrument used to analyze samples collected for the HPS Phase I GDGI. All instruments will be serviced at scheduled intervals, as necessary to optimize factory specifications. Routine preventive maintenance and major repairs will be documented in a maintenance logbook. An inventory of items to be kept ready for use in case of instrument failure will be maintained and restocked as needed. The spare parts will include replacements for parts subject to frequent failure, parts that have a limited lifetime of optimum performance, and parts that cannot be obtained in a timely manner.

As required by Navy Installation Restoration Chemical Data Quality Manual guidelines (NFESC 1999), a description of specific preventive maintenance procedures for laboratory equipment is available in the laboratory's QA plan and in the written SOPs maintained by the laboratory. Those documents identify the personnel responsible for major, preventive, and daily maintenance procedures; the types and frequency of maintenance to be performed; and procedures for documentation of maintenance activities.

B7.4 CALIBRATION OF LABORATORY ANALYTICAL EQUIPMENT

Laboratory instrument calibration procedures and frequencies will follow referenced analytical method requirements. Qualified analysts will calibrate the instrument and will document the procedure in an instrument logbook.

Laboratory calibration procedures and frequencies are listed in the subcontracted laboratory's QA plan, the written SOPs maintained by the laboratory, and the analytical methods referenced in Section B5 of this QAPP. Laboratory instruments will be calibrated by the procedures and at the frequencies specified in CLP QC requirements. For methods not defined, CLP-referenced method requirements will be followed.

B7.4.1 Calibration Standards

Calibration standards will be obtained by the laboratory from the EPA repository or commercial vendors for both inorganic and organic compounds and analytes. Stock solutions for surrogate parameters and other inorganic mixes will be made from reagent-grade chemicals or as specified in the method SOP. Stock standards will also be used for intermediate standards from which calibration standards are made. Special attention will be given to expiration dating, proper labeling, proper refrigeration, and freedom from contamination. Documentation related to receipt, mixing, and use of standards will be recorded in the appropriate laboratory logbook. Logbooks must be bound. Specific handling and documentation requirements for the use of standards will be provided in the selected laboratory's QA manual.

B7.4.2 Corrective Action Procedures

Instrument malfunctions will require immediate corrective action. Actions should be documented in field or laboratory logbooks. No other formal documentation is required, unless data quality is adversely affected or further corrective action is necessary. On-the-spot corrective actions will be taken, as necessary, in accordance with the procedures described in the laboratory QA plan and SOPs.

B8 INSPECTION AND ACCEPTANCE FOR SUPPLIES AND CONSUMABLES

Analytical laboratories are required to provide certified-clean containers for all analyses. The subcontract laboratories will maintain an inventory of the analytical supplies required for the analytical procedures, as described in Section B5.

Solvents and reagents used by the laboratories in all analytical procedures will be documented in a laboratory logbook. At a minimum, information about the manufacturer, lot number, date received, and date opened should be included. Solvents and reagents will be tested for contamination before use. The results of that procedure and any other quality inspections will be documented in a laboratory notebook.

Subcontracted laboratories will maintain and follow a written SOP for the decontamination of glassware used in analytical procedures. Laboratories will check the calibration of all analytical balances and automatic pipettes daily and document the results in a laboratory logbook. Analytical balances will be recalibrated as necessary in accordance with the laboratory’s written SOPs.

B9 NONDIRECT MEASUREMENTS

The following sections outline data management in the field and laboratory. Electronic data generated from this project will be delivered to the Navy in a format compatible with NEDTS.

B9.1 FIELD DATA MANAGEMENT

The TtEMI data and QA manager will be responsible for review, transfer, and storage of data collected in the field for the facility. The TtEMI field team leader will maintain documentation of sampling, logging, and field measurements. The TtEMI field team leader will also maintain daily QC reports and note any variance from SOPs.

B9.2 LABORATORY DATA MANAGEMENT

When samples are received at the laboratory, the laboratory sample custodian will reconcile the information on the chain-of-custody forms with the sample bottles received. The sample custodian will document any anomalies and report them to the laboratory project manager (PM), who will contact the TtEMI project chemist. Anomalies will be resolved with the TtEMI project chemist. The information on the chain-of-custody forms will then be entered into the laboratory's information management system.

The LIMS will be used to track samples from the time of receipt through each stage of sample preparation, analysis, and final reporting. Data will be transferred from the analytical instrument electronically to the laboratory's LIMS, or qualified personnel will enter the data through terminals. The laboratory will be responsible for tracking all QC parameters and sample results by SDG. Any data that exceed the QC limits specified for this project will be documented. QC anomalies that directly affect data quality will immediately be communicated to the TtEMI project chemist. The laboratory will implement and document any corrective actions necessary as a result of QC anomalies. The contract laboratory will generate the EDD and a CLP-like data package after all data have been reviewed and approved by the appropriate laboratory personnel. The EDD and data package will then be delivered to the TtEMI project chemist.

The laboratory PM will be responsible for proper sample handling and documentation from the time samples are received until the data package and EDD are submitted. The laboratory will use sample receipt forms and nonconformance memoranda to document nonconformance information and disseminate it to the TtEMI project chemist.

B9.3 TETRA TECH EM INC. DATA MANAGEMENT

The laboratory will be responsible for sending a hard copy of the data package and the EDD on computer diskette to the TtEMI project chemist. The EDD and hardcopy data will be checked to ensure that their format and content comply with the specifications of TtEMI. Any errors or missing information detected will be thoroughly investigated. The laboratory will be required to regenerate the EDD or data package, if necessary.

Copies of the EDD and hardcopy data will be sent to an independent reviewer for data validation, as described in Section D1. The validator will apply qualifiers to the data, as appropriate. The TtEMI project chemist will conduct a technical review of the data validation report, as described in Section D1. The validated data will be submitted to data entry staff for entry into the database. The final version of the data validation report will be stored with the hardcopy analytical report.

C1 ASSESSMENTS AND RESPONSE ACTIONS

Any problems encountered during the field investigation will require appropriate corrective action procedures to ensure that they are resolved. This section describes the types of audits that may be completed, corrective action procedures that will be undertaken in the event that problems occur in the field or the laboratory, and QA reports to management. Oversight of QA activities will be completed through three types of audits, described in the following section.

C1.1 PERFORMANCE, SYSTEM, AND FIELD AUDITS

An audit evaluates the capability and performance of a measurement system or its components and identifies problems that warrant correction. Three types of audits may be conducted during the field work for this project: (1) performance, (2) system, and (3) field. The SWDIV QAO, or the TtEMI QA program manager, project QA officers, or senior technical staff will complete audits at scheduled intervals, as necessary. The SWDIV QAO is independent of the Navy RPMs, and the TtEMI auditors will be independent of the activities audited. Technical expertise and experience in auditing will be considered in selecting a TtEMI auditor or audit team.

Audits may include reviews of adherence to the project plan, training status, health and safety procedures, QC data, calibrations, and conformance to sampling and field SOPs. Audits may also review compliance with laws, regulations, policies, and procedures. After a TtEMI audit has been completed, the auditor or audit team will submit an audit report to the TtEMI project manager, the program manager, the IC, the SWDIV QAO, and ultimately the Navy RPM. The report will also be included in the project summary report. The QA program manager will coordinate a management review if any outstanding deficiencies are noted. An example of an audit report form is provided in Appendix 1 of this QAPP.

The auditor or audit team can issue a corrective action request form to identify and schedule specific corrective actions to be undertaken and completed by the project manager. The auditor or audit team verifies completion of corrective action. After corrective actions have been accepted and verified, the corrective action request form will be used to close the audit. An example of a corrective action request form is presented in Appendix 1. A flow chart depicting the QA audit pathway is presented on Figure C-1.

C1.1.1 Performance Audits

A performance audit is a review of existing project and QC data to evaluate the accuracy of a total measurement system or a component of the system. Performance audits are an independent QA function of the SWDIV QAO. TtEMI also conducts performance audits. TtEMI has contracts in place with several laboratories approved by the Navy and conducts a laboratory audit as a condition of contract award. Laboratory performance is monitored through data validation and service quality. If performance problems arise, the issues are evaluated to determine the need for additional performance audits of the laboratory. Internal audit routines for the laboratory are described in the laboratory QA plan and follow Navy Installation Restoration Chemical Data Quality Manual guidance (NFESC 1999).

C1.1.2 System Audits

A system audit may be used to verify adherence to QA policies and SOPs. This type of audit may consist of on-site review of measurement systems. In addition, procedures for measurement, QC, and documentation may be evaluated.

C1.1.3 Field Audits

A field audit involves an on-site visit by the auditor or audit team. Items to be examined include the availability and implementation of approved field procedures, calibration and operation of equipment; chain-of-custody procedures; packaging, storing, and shipping of samples; health and safety procedures; documentation of procedures and instructions; and documentation of nonconformance. Field audits are scheduled at the program level. Field schedules are provided to the Program QA manager who may select this project for a field audit.

C1.2 CORRECTIVE ACTION PROCEDURES

An effective QA program requires prompt and thorough correction of nonconformance conditions that affect quality. Rapid and effective corrective action minimizes the possibility that data or documentation will be questionable. There are two types of corrective actions: immediate and long-term. Immediate corrective actions include correction of documentation deficiencies or errors, repair of inaccurate instruments, or correction of inadequate procedures. The source of the problem is generally obvious and can be corrected at the time of the observation. Long-term corrective actions are designed to eliminate the sources of problems. Examples of long-term corrective actions are correction of systematic errors in sampling or analysis and correction of procedures that produce questionable results. Corrections can be made through additional personnel training, replacement of instruments, or procedural improvements. One or more corrections may be necessary.

All QA problems and corrective actions will be documented to provide a complete record of QA activities and to help to identify necessary long-term corrective actions. Defined responsibilities are required for scheduling, performing, documenting, and ensuring the effectiveness of the corrective action. This section describes the corrective action procedures to be followed in the field and laboratory.

C1.2.1 Field Procedures

Field nonconformance conditions are defined as occurrences or measurements that are unexpected or that do not meet established acceptance criteria and will affect data quality if corrective action is not implemented. Examples of nonconformance are:

- Incorrect use of field equipment
- Improper sample collection, preservation, and shipment procedures
- Incomplete field documentation, including chain-of-custody records
- Incorrect decontamination procedures
- Incorrect collection of QC samples

Corrective action procedures will depend on the severity of the nonconformance. In cases in which field personnel implement immediate and complete corrective action, the corrective action will be recorded in the field logbook and summarized in the daily QC report. An example of a daily QC report is presented in Appendix 1 of this QAPP.

Nonconformances that have caused a substantial impact on data quality require the completion of a corrective action request form. The form may be completed by an auditor or by any individual who suspects that any aspect of data integrity is being affected by a field nonconformance. A separate form must be completed for each nonconformance. An example of a corrective action request form is presented in Appendix 1 of this QAPP.

Copies of the corrective action request form will be distributed to the project manager, the field team leader, the project QA manager, and the project file. The project manager, the field team leader, and the project QA manager will meet to discuss the appropriate steps to be taken to resolve the problem and will take the following steps:

- Determine when and how the problem developed
- Assign responsibility for investigation and documentation of the problem
- Identify the corrective action that will eliminate the problem
- Design a schedule for completing the corrective action
- Assign responsibility for implementing the corrective action
- Document and verify that the corrective action has eliminated the problem
- Notify the Navy of the problem and the corrective action taken

The QA program manager can require that data acquisition be limited or discontinued until the corrective action has been completed and the nonconformance has been eliminated. The QA program manager can also request the reanalysis of any or all data acquired since the system was last in control.

C1.2.2 Laboratory Procedures

Laboratory procedures for corrective action and a description of out-of-control situations that require corrective action are provided in the laboratory QA plan. At a minimum, corrective action will be implemented when any of the following three conditions occurs: (1) control limits are exceeded, (2) method QC requirements are not met, or (3) sample holding times are exceeded. Out-of-control situations will be reported to the project chemist within 2 working days after they are identified. In addition, a corrective action report signed by the laboratory director or project manager and the laboratory QC coordinator will be provided to the project chemist.

C1.3 REPORTS TO MANAGEMENT

Several reports that address QA issues will be prepared during field work for the HPS Phase I GDGI. Each of those reports is summarized in this section.

C1.3.1 Daily Quality Control Reports

The daily QC report will summarize daily field activities throughout the field program. The report will include work completed, including any QA/QC activities; health and safety activities; problems encountered; and corrective actions taken. The daily QC report is prepared by the field team leader and submitted to the project manager.

C1.3.2 Project Monthly Progress Report

A summary report will be prepared by the project manager. The report will include:

- Status of the project
- Instrument, equipment, or procedural problems affecting QA and recommended solutions
- Objectives from the previous report that were achieved
- Objectives from the previous report that were not achieved
- Work planned for the next month

The information listed above will also be required from any subcontractors, and the subcontractors' report will be included in the monthly progress report, presented under CTOs 005 and 011.

C1.3.3 Quality Control Summary Report

A QC summary report (QCSR) will be prepared by TtEMI and submitted to the Navy RPM with each annual report for the activity. The QCSR will include a summary and evaluation of the QC completed during the task and will indicate the duration and location of storage for the complete data packages. Particular emphasis will be placed on determining whether project DQOs were met and whether data are of sufficient quality to support required decisions.

D1 DATA VALIDATION AND USABILITY

The following two sections discuss the requirements and methods for review, verification, and validation of data. Section D2 discusses the process for reconciling the data generated with the DQOs for the task.

D1.1 DATA REVIEW, VERIFICATION, AND VALIDATION REQUIREMENTS

Data from the HPS Phase I GDGI will be reviewed and verified before they are entered in the database. At a minimum, 20 percent of the laboratory analytical data will be randomly selected and fully validated. The remaining laboratory analytical data will undergo cursory validation. All data will be validated according to Navy SWDIV Environmental Work Instruction 4EN.1 (EWI #1) (SWDIV 1999) and the national functional guidelines for organic (EPA 1994a) and inorganic (EPA 1994b) data review.

D1.2 VERIFICATION AND VALIDATION METHODS

Validation and verification of data generated during field activities are essential to obtaining data of defensible and acceptable quality. Verification methods for field and laboratory activities are presented in the following two sections; validation requirements are presented in Sections D1.2.3.1 through D1.2.3.4.

D1.2.1 Verification of Field Data

Project team personnel will validate field data through reviews of data sets to identify inconsistencies or anomalous values. If possible, any inconsistencies discovered will be resolved immediately by seeking clarification from the field personnel responsible for data collection. To obtain defensible data, field personnel will be responsible for following the sampling and documentation procedures described in this QAPP and the accompanying FSP.

Data values that differ significantly from the population are called "outliers." A systematic effort will be made to identify any outliers or errors before field and laboratory personnel report the data. Outliers can result from improper sampling or analytical methodology, matrix interference, data transcription errors, and calculation errors, or they may represent inherent variability in the sample. Outliers resulting from errors found during data verification will be identified and corrected. Outliers that cannot be attributed to analytical, calculation, or transcription errors will be reported in the case narrative section of the analytical report, but will not necessarily be excluded from data analysis.

D1.2.2 Verification of Laboratory Data

Laboratory personnel will verify analytical data at the time of analysis and reporting through reviews of the raw data for any nonconformance with the requirements of the analytical method. Detailed procedures for laboratory verification and corrective action will be provided in the laboratory's QA plan.

D1.2.3 Validation of Analytical Data

The following four sections describe the validation requirements for laboratory analytical data.

Technical Requirements

In accordance with SWDIV Environmental Work Instruction 4EN.1 (EWI #1) (SWDIV 1999), laboratory analytical data will be validated by an independent, third-party subcontractor, using the EPA national functional guidelines for organic (EPA 1994a) and inorganic data review (EPA 1994b).

Cursory Data Validation

Cursory validation will be completed on the data summary packages for analysis of groundwater samples by CLP and non-CLP methods. The criteria for cursory data validation are presented in Section D1.2.3.4. The data reviewer is required to notify TtEMI and request any information needed from the laboratory. All data will be subjected to the review process. Data summary packages consist of sample results and QA/QC summaries (equivalent to CLP forms I through X for organic analysis, and forms I through XIV for inorganic analysis), including calibration and internal standard data. No minimum number of samples will be required for an SDG; however, the number of samples will not exceed a maximum of 20.

Full Data Validation

Full validation will be completed on data packages for analysis of groundwater samples by CLP and non-CLP methods. The criteria for full data validation are presented in Section D1.2.3.4. The data reviewer is required to notify TtEMI and request any information needed from the laboratory. All data will be subjected to the review process. At a minimum, full validation will be required for 20 percent of all project samples; the remaining samples will require cursory validation. Data packages consist of sample results, QA/QC summaries (equivalent to CLP forms I through X for organic analysis and forms I through XIV for inorganic analysis), and raw data associated with the sample results and QA/QC summaries.

Criteria for Data Validation

The QC criteria to be reviewed for both cursory and full validations are identified as follows:

Cursory Data Validation

1. CLP Organic Analyses
   - Holding times
   - Calibration
   - Blanks
   - Surrogate recovery
   - MS and MSD
   - Blank spike or LCS recovery
   - Internal standard performance
   - Overall assessment of data for an SDG
   - Field duplicate sample analysis

2. CLP Inorganic Analyses
   - Holding times
   - Calibration
   - Blanks
   - LCS recovery
   - MS recovery
   - Matrix duplicate sample analysis
   - Field duplicate sample analysis
   - ICP serial dilution
   - Overall assessment of data for an SDG

3. Non-CLP Organic Analyses
   - Method compliance
   - Holding times
   - Calibration
   - Blanks
   - Surrogate recovery
   - MS and MSD recovery
   - Blank spike or LCS recovery
   - Internal standard performance
   - Other laboratory QC specified by the method
   - Overall assessment of data for an SDG
   - Field duplicate sample analysis

4. Non-CLP Inorganic and Physical Analyses

- Holding times
- Calibration
- Blanks
- MS and MSD recovery
- Internal standard performance
- LCS recovery
- Field duplicate sample analysis
- Other laboratory QC specified by the method
- Overall assessment of data for an SDG

Full Data Validation

1. CLP Organic Analyses

- Holding times
- GC/mass spectrometry tuning
- Calibration
- Blanks
- Surrogate recovery
- MS and MSD recovery
- Internal standard performance
- Target compound list identification
- Compound quantitation and reported detection limits
- TICs
- Field duplicate sample analysis
- Blank spike or LCS analysis
- System performance
- Overall assessment of data for an SDG

2. CLP Inorganic Analyses

- Holding times
- Calibration
- Blanks
- ICP interference check sample
- LCS recovery
- MS recovery
- Field duplicate sample analysis
- Matrix duplicate sample analysis
- Graphite furnace atomic absorption QC
- Sample result verification

- ICP serial dilution
- Overall assessment of data for an SDG

3. Non-CLP Organic Analyses
    - Method compliance
    - Holding times
    - Calibration
    - Blanks
    - Surrogate recovery
    - MS and MSD recovery
    - LCS or blank spike
    - Internal standard performance
    - Field duplicate sample analysis
    - Other laboratory QC specified by the method
    - Detection limits
    - Compound identification
    - Compound quantitation
    - Sample results verification
    - Overall assessment of data for an SDG

4. Non-CLP Inorganic and Physical Analyses
    - Holding times
    - Calibration
    - Blanks
    - MS and MSD recovery
    - Internal standard performance
    - LCS
    - Field duplicate sample analysis
    - Other laboratory QC specified by the method
    - Detection limits
    - Analyte identification
    - Analyte quantitation
    - Sample results verification
    - Overall assessment of data for an SDG

D2 RECONCILIATION WITH DATA QUALITY OBJECTIVES

The first step of the DQO process (see Table A-2) presented the following project objectives: (1) assess the condition of all existing wells, (2) measure basewide water levels to determine the pieziometric surface at existing A- and B-aquifer wells, (3) perform additional B-aquifer characterization in Parcels C and D by sampling existing and newly installed wells for hydrogeologic and chemical parameters, and (4) resample A-aquifer wells in Parcels C and D for chemical parameters to characterize the existing extent of the RUs. The sampling and laboratory methods and procedures described in detail in this QAPP should provide data of sufficient quality to conduct an initial assessment of the groundwater data gaps in the study areas at HPS. The data from the Phase I activities will be evaluated and the need for additional data will be assessed for potential Phase II activities. Phase II activities may include: (1) collecting a second round of groundwater samples, as necessary, from existing and newly installed monitoring wells sampled during Phase I; (2) installing additional monitoring wells as the Phase I results indicate is necessary; and (3) conducting additional hydrogeologic characterization of the A- and B-aquifers and the bedrock water-bearing zone. The scope of work for the Phase II activities will be outlined in a separate FSP and QAPP.

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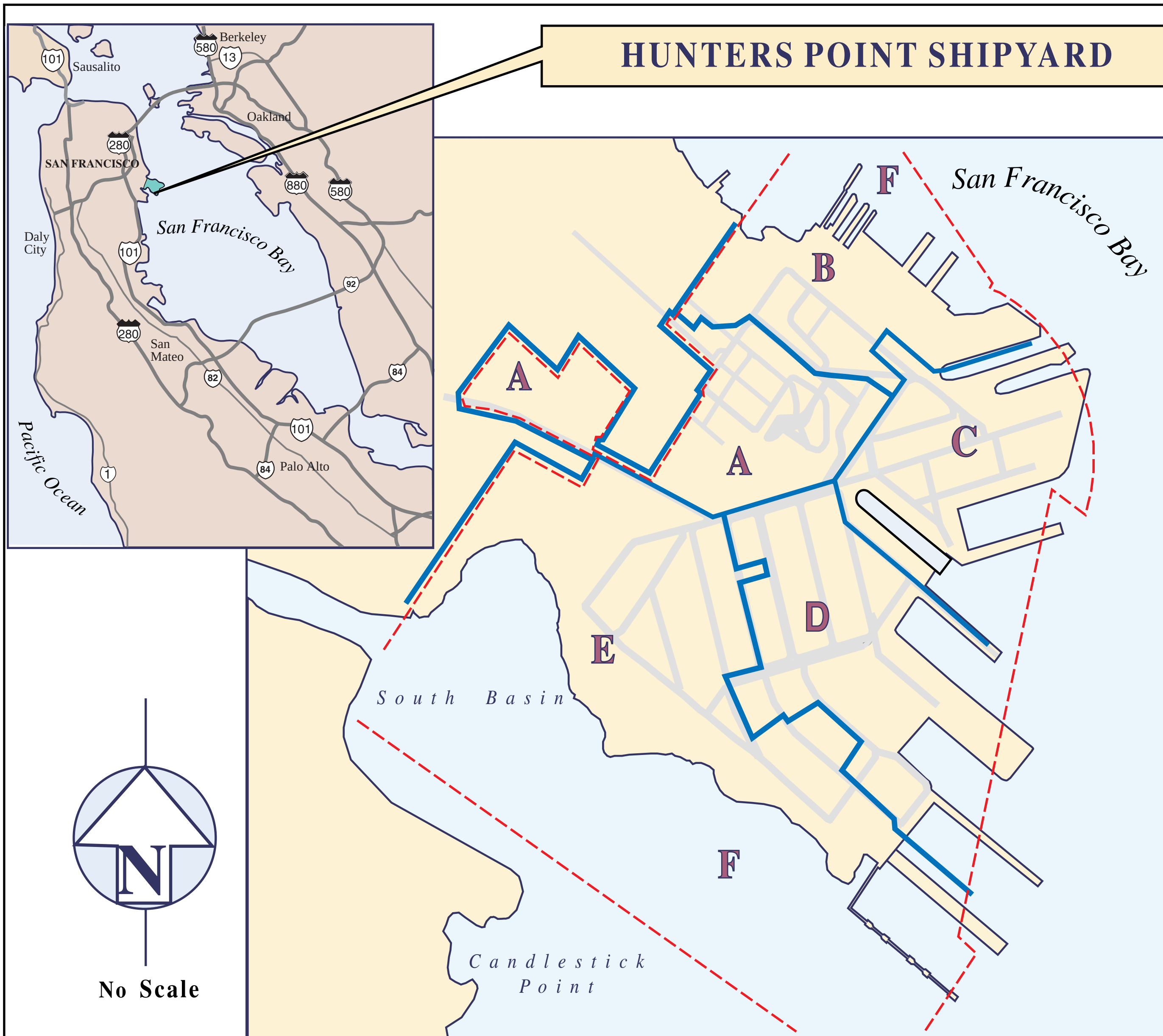
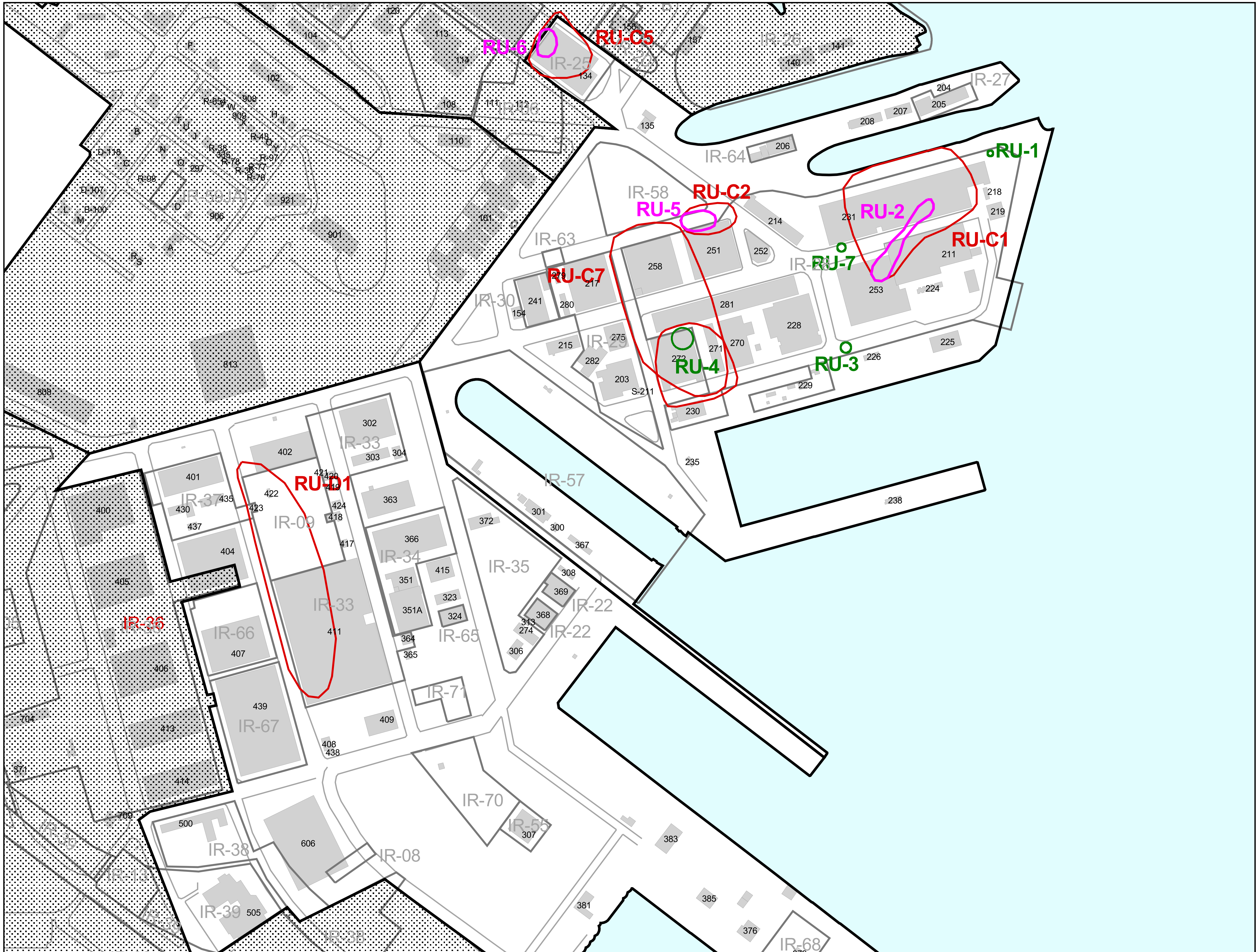
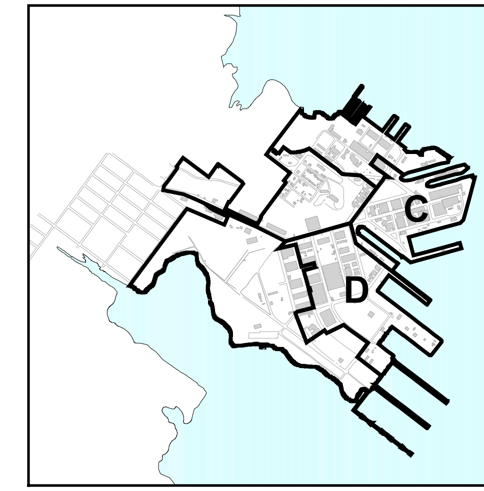
FIGURES



HUNTERS POINT SHIPYARD

DEPARTMENT OF THE NAVY	NAVAL FACILITIES ENGINEERING COMMAND
SOUTHWEST DIVISION SAN DIEGO, CALIFORNIA	
HUNTERS POINT SHIPYARD	SAN FRANCISCO, CALIFORNIA
FIGURE A-1 **FACILITY LOCATION MAP** **HUNTERS POINT SHIPYARD**	





Remedial Units Eco RAO
Remedial Units Human Health & Eco RAO
Revised Remedial Units
Remedial units shown represent areas with point exceedances that are proposed for further evaluation.

HPS Parcels
A
B
C
D
E

IR Sites
Roads
Buildings
San Francisco Bay

N

200 0 200 400 Feet

Tetra Tech EM Inc.

HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE A-2

PARCELS C AND D
GROUNDWATER AREAS

07/20/00 v:\hunters point\projects\gw presentation (2-7)\copy (5) of basewide.apr (ltd themes) TtEMI-SF Deborah Cheg

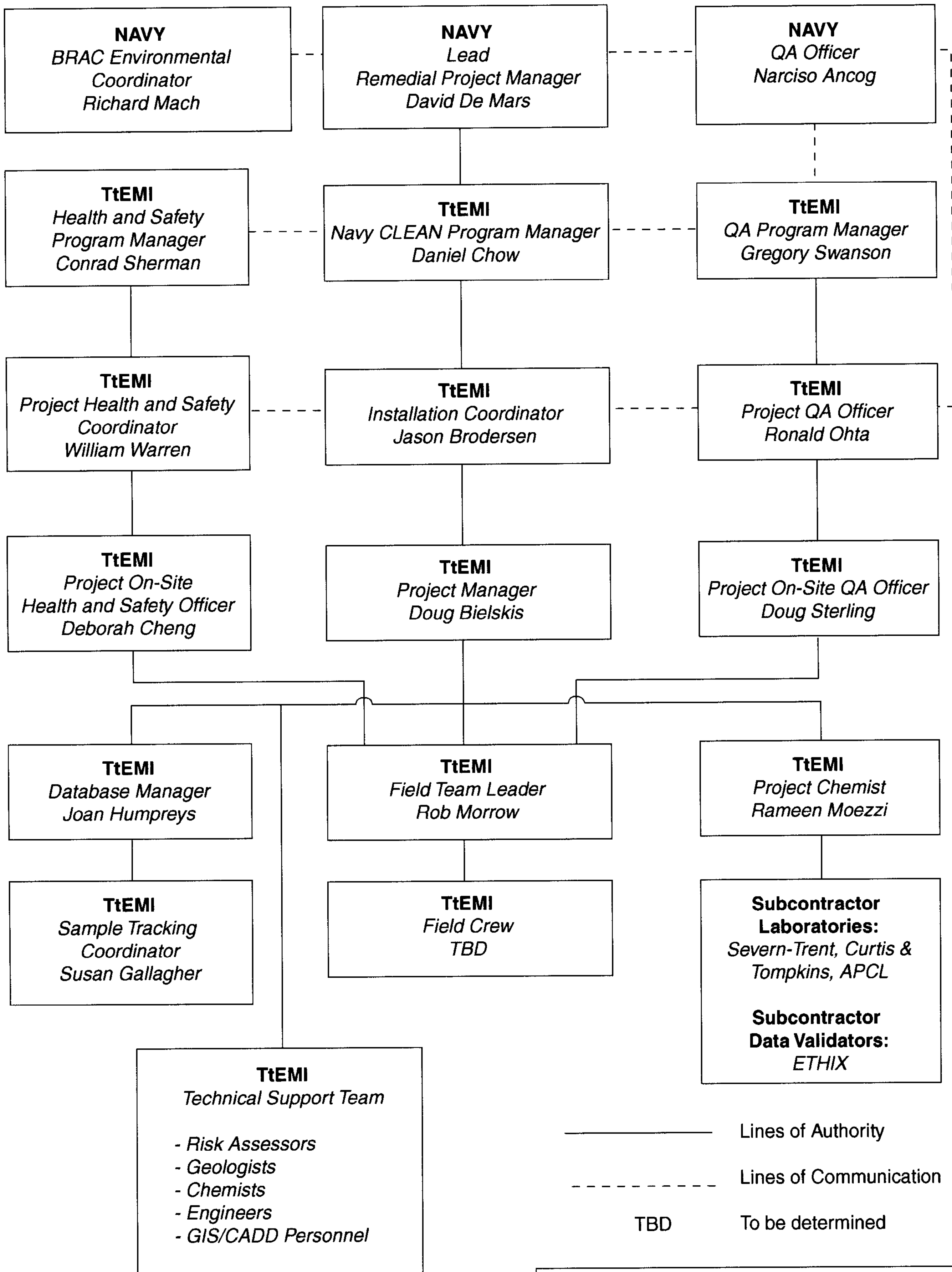


Figure A-3
Groundwater Data Gap Investigation Organization Flowchart

S:/CLEAN/HPS/Parcel E/Basewide GW Sampling/FSP-QAPP

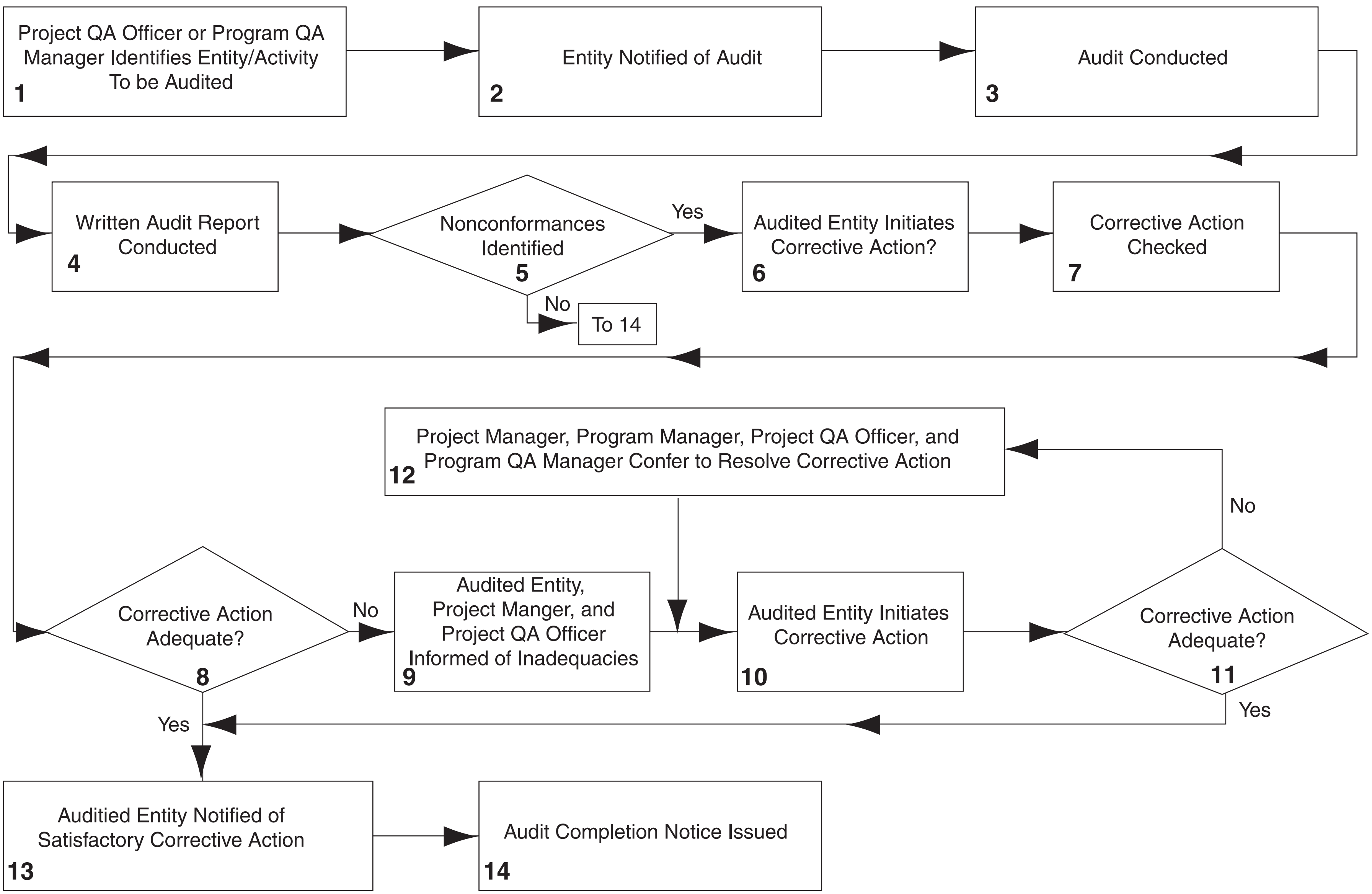


Figure C-1
Quality Assurance Audit Flowchart

APPENDIX 1

FIELD FORMS AND QUALITY CONTROL REPORTS

Field Instrument Calibration Log

CTO No.: ______________________________

Project Name: ______________________________

Instrument Type	Instrument SN	Calibration Type	Date	By

TETRA TECH EM INC.
MONITORING WELL INSPECTION FORM

Monitoring Well No.:______________ **Date:**______________

Detail the condition of the items identified below, as applicable to each individual well:

External well identification:

Internal well identification:

Concrete pad and surrounding area:

Well vault or stickup:

Well lid (if applicable):

Rubber seal (if applicable):

Lid bolts (if applicable):

Well cap:

Well lock:

Water level measuring mark and/or notch:

Was there standing water in the well vault/well stickup? Yes_____ No_____

Note any abnormalities regarding the well vault in relation to the surrounding grade:

(inspection information continued on reverse)

TETRA TECH EM INC.
MONITORING WELL INSPECTION FORM
(CONTINUED)

If necessary, using the following space, note any discrepancies between the well location portrayed on the well location map and the location of the well as identified in the field.

Location sketch:

Identify all light maintenance completed during well inspection:

Additional Comments:

Prepared by: ______________________

TETRATECH EM INC

MONITORING WELL COMPLETION RECORD

MONITORING WELL

MONITORING WELL NO.: ______
PROJECT: ______
SITE: ______
BOREHOLE NO.: ______
WELL PERMIT NO.: ______
TOC TO BOTTOM OF WELL: ______

DRILLING INFORMATION

DRILLING BEGAN:
DATE: ______ TIME: ______
WELL INSTALLATION BEGAN:
DATE: ______ TIME: ______
WELL INSTALLATION FINISHED:
DATE: ______ TIME: ______
DRILLING CO.: ______
DRILLER: ______
LICENSE: ______
DRILL RIG: ______
DRILLING METHOD:
- ☐ HOLLOW STEM AUGER
- ☐ AIR ROTARY
- ☐ OTHER: ______

DIAMETER OF AUGERS:
ID: ______ OD: ______

WELL CASING

☐ SCHEDULE 40 PVC
☐ OTHER: ______
PRODUCT: ______
MFG. BY: ______
CASING DIAMETER:
ID: ______ OD: ______
LENGTH OF CASING: ______

WELL SCREEN

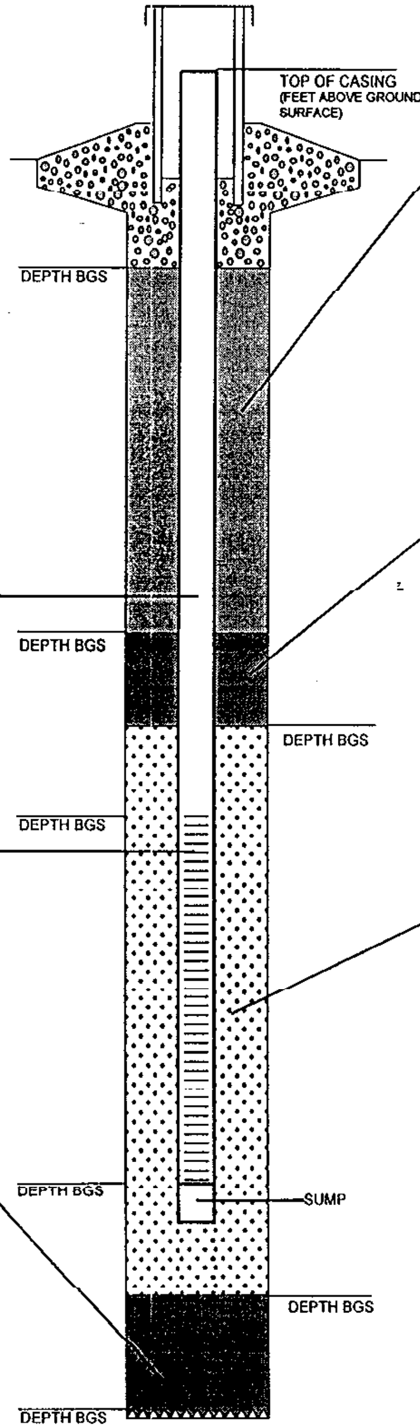
☐ SCHEDULE 40 PVC
☐ OTHER: ______
PRODUCT: ______
MFG. BY: ______
CASING DIAMETER:
ID: ______ OD: ______
SLOT SIZE: ______
LENGTH OF SCREEN: ______

BOREHOLE BACKFILL

AMOUNT CALCULATED: ______
AMOUNT USED: ______
☐ BENTONITE CHIPS, SIZE: ______
☐ BENTONITE PELLETS, SIZE: ______
☐ SLURRY: ______
☐ FORMATION COLLAPSE: ______
☐ OTHER: ______
PRODUCT: ______
MFG. BY: ______
METHOD INSTALLED:
☐ POURED ☐ TREMIE
☐ OTHER: ______

SURFACE COMPLETION

☐ FLUSH MOUNT
☐ ABOVE GROUND WITH BUMPER POST
☐ CONCRETE ☐ ASPHALT



SURVEY INFORMATION

TOC ELEVATION: ______
GROUND SURFACE ELEVATION: ______
NORTHING: ______
EASTING: ______
DATE SURVEYED: ______
SURVEY CO.: ______

ANNULAR SEAL

VOLUME CALCULATED: ______
AMOUNT USED: ______
☐ GROUT FORMULA (PERCENTAGES)
PORTLAND CEMENT: ______
BENTONITE: ______
WATER: ______
☐ PREPARED MIX
PRODUCT: ______
MFG. BY: ______
METHOD INSTALLED:
☐ POURED ☐ TREMIE
☐ OTHER: ______

BENTONITE SEAL

VOLUME CALCULATED: ______
AMOUNT USED: ______
☐ PELLETS, SIZE: ______
☐ CHIPS, SIZE: ______
☐ OTHER: ______
PRODUCT: ______
MFG. BY: ______
METHOD INSTALLED:
☐ POURED ☐ TREMIE
☐ OTHER: ______
AMOUNT OF WATER USED: ______

FILTER PACK

☐ PREPACKED FILTER
VOLUME CALCULATED: ______
AMOUNT USED: ______
☐ SAND, SIZE: ______
PRODUCT: ______
MFG. BY: ______
METHOD INSTALLED.
☐ POURED ☐ TREMIE
☐ OTHER: ______
WATER LEVEL: ______
(BTOC AFTER WELL INSTALLATION)

CENTRALIZERS USED?

☐ YES ☐ NO;
CENTRALIZER DEPTHS: ______

LEGEND

BGS = BELOW GROUND SURFACE
BTOC = BELOW TOP OF CASING
N/A = NOT APPLICABLE
NR = NOT RECORDED
TOC = TOP OF CASING

TETRA TECH EM INC.

GROUNDWATER LEVEL MEASUREMENTS LOG

Circle type of organic vapor meter used: PID FID

Well Number	PID/FID Reading (ppm)	Time	Depth to Groundwater (ft.) (three measurements)			Depth to Bottom (ft.)	Comments
			1st	2nd	3rd		

Date: __________

Field Staff: __________ Field Staff Signature: __________

Page No.: __________

Tetra Tech EM Inc.

MICROPURGING GROUNDWATER SAMPLING DATA SHEET

Page ____ of __

Date ________

Well Name ____________________

Project ____________________

Project No. ____________________

Well Location ____________________

Sample Date ____________________

Sampling Personnel ____________________

Sample ID ____________________

Duplicate ID ____________________

Screen Interval ____________________

Station Elevation ________ GND ____ TOC ____

Static Water Level (from TOC) ____________________

Well Stick Up ____________________

Static Elevation ____________________

Well Depth ________ MEAS ____ RPTD ____

Feet of Water ____________________

Gallons/Foot ____________________

Casing Volume ____________________

Immiscible Phases Present ☐ Yes ☐

Type ____________________

Measured with ____________________

PID Readings (background) ____________________

PID Reading (TOC) ____________________

Wells Installed by ____________________

Installation Date ____________________

Development Date(s) ____________________

FIELD CHEMISTRY CALIBRATIONS

Date/Time ____________________ Spec. Conductance: Standard ________ µmhos/cm at 25•C Reading ________ µmhos/cm at ____

pH: pH 4.00 - ______ at ______ •C pH 7.00 - ______ at ______ •C pH 10.00 - ______ at ______ •C Slope ________

Dissolved Oxygen: D.O. Meter ______ mg/L at ______ •C PID: Calibration Gas ________ PPM ______ Span ______ Reading ______

PURGING

Time	Discharge Rate (mL/min)	Dissolved Oxygen (mg/L)	pH	Eh/ORP (mV)	Temp. (•C)	Specific Conduct. (µmhos/cm at •C)	Turbidity (NTU)	Cumulative Volume of Water Removed (Purged)		PID/OVA Reading		Depth to Water (ft)	Comments
								Gallons	Casing Vol.	Location	Value		

SAMPLE PARAMETERS

Condition of well: ____________________

Remarks: ____________________

FIELD EQUIPMENT

pH Meter ____________ Serial Number ____________

Spec. Cond. Meter ____________ Serial Number ____________

Pump ____________ Serial Number ____________

Water Level Meter ____________ Serial Number ____________

D.O. Meter ____________ Serial Number ____________

Filter Apparatus ____________ Filters ____________

Temperature Measure ____________

Interface Probe ____________ Serial Number ____________

PID/OVA ____________ Serial Number ____________

Field Chemistry Calibrations

Fractions ____________

____

____

Number of Bottles ____________

Sample Depth ____________

Field Notebook ____________

Sample Method ____________

____

Discharge Water Containerized ☐ Yes ☐ No

Tet: Tech EM Inc.
San Francisco Office

135 Main St. Suite 1800
San Francisco, CA 94105
415-543-4880
Fax 415-543-5480

J440

Chain of Custody Record

Page ____ of ____

	PO#	Lab:
Project name:	TtEMI technical contact:	Field samplers:
Project number:	TtEMI project manager:	Field samplers' signatures:

Sample ID	Sample Description/Notes	Date	Time	Matrix	40 ml VOA	1 Liter Amber	1 Liter Poly	Brass Tube	Glass Jar				CLP VOA	CLP SVOA	CLP Pest/PCBs	CLP Metals	TPH Purgeables	TPH Extractables									

(No./Container Types: 40 ml VOA through last blank column; Analysis Required: CLP VOA onward; Preservative Added row above Analysis Required.)

EXAMPLE

	Name (print)	Company Name	Date	Time
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				

Turnaround time/remarks:

Tetra Tech EM Inc.

Daily Quality Control Report

(Page 1 of 2)

Project Name:	**Date:**
Project Number:	**Day:**
Weather:	**Wind:**
Temperature:	**Humidity:**

Personnel on Site

Field Team Leader:

Subcontractors on Site:

Equipment on Site

Work Performed (Including Sampling)

Quality Control Activities

Health and Safety Levels and Activities

Problems Encountered / Corrective Action Taken

Tetra Tech EM Inc.

Daily Quality Control Report

Deviations from Field Work Plan

Additional Notes

Anticipated Activities for Tomorrow

Distribution:	Submitted By:
	Signature Date

Audit Report

Tetra Tech EM Inc.

Project Name: ______________________ Date of Audit: ______________________

Project No.: ______________________ Project Manager: ______________________

Audit Team Members: ______________________

Brief Description of Project:

____

____

Audit Summary:

____

____

Corrective Action Required:

____

____

Quality Improvement Opportunities:

____

____

Remarks:

____

____

Auditor Signature: ______________________ Date: ______________________

cc: TtEMI Program QA Manager

Corrective Action Request Form
(Page 1 of 2)

Tetra Tech EM Inc.

Project Name: ______________________ **Date:** ______________________

Project No.: ______________________ **Project Manager:** ______________________

Location: ______________________

To (Project Manager): ______________________

From (Audit Team Members): ______________________

Description Problem:

____

____

____

____

Corrective Action Required:

____

____

____

____

The above corrective action must be completed by (Date): ______________________

Acknowledgement of Receipt

____
(Signature and Date)

Corrective Action Request Form

(Page 2 of 2)

Tetra Tech EM Inc.

Corrective Action Taken:

Project Manager:

(Signature and Date)

Audit Team Members:

Corrective Action *is / is not* satisfactory

(Date and Initial)

Remarks:

QC Coordinators:

Corrective Action *is / is not* satisfactory

(Date and Initial)

Remarks:

cc: Program QA Manager

APPENDIX 2

ANALYTICAL METHODS PROTOCOL

TABLE 2-1

GROUNDWATER ANALYTICAL PROTOCOL
PHASE 1 GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Analysis	Method/ Reference	Sample Volume, Container	Extra MS/MSD Volume	Preservation	Analytical Holding Time
Off-Site Laboratory Analyses – Analytes of Concern					
Volatile Organic Compounds	CLP VOC– low level	Two 40-mL VOC vials	Three 40-mL VOC vials	Sample must be collected without headspace. Preserve with HCl to pH ≤ 2 and cool to 4°C.	14 days (7 days if unpreserved)
Semivolatile Organic Compounds	CLP SVOC– low level	Two 1-L amber glass containers	Four 1-L amber glass containers	Unpreserved. Cool to 4°C.	7 days(1)
Pesticides/PCBs	CLP Pest/PCBs – low level	Two 1-L amber glass containers	Four 1-L amber glass containers	Unpreserved. Cool to 4°C.	7 days(1)
Metals (Dissolved)	CLP Metals	One 1-L polyethylene container	One 1-L polyethylene container	Field-filtered (to 0.45 µm) Preserve with HNO_3 to pH<2 and cool to 4°C	Hg: 28 days Others: 6 months
Hexavalent Chromium	EPA 7196A	One 500-ml polyethylene container	Two 500-ml polyethylene containers	Filtered at laboratory Unpreserved. Cool to 4°C.	24 hours
TPH-Purgeable (gasoline range)	EPA 8015B	Two 40-mL VOC vials	Three 40-mL VOC vials	Sample must be collected without headspace. Preserve with HCl to pH ≤ 2 and cool to 4°C.	14 days (7 days if unpreserved)
TPH-Extractable (diesel and motor oil range)	EPA 8015B (silica gel cleanup)	Two 1-L amber glass containers	Four 1-L amber glass containers	Unpreserved. Cool to 4°C.	7 days(1)

TABLE 2-1

GROUNDWATER ANALYTICAL PROTOCOL
PHASE 1 GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 3)

Analysis	Method/ Reference	Sample Volume, Container	Extra MS/MSD Volume	Preservation	Analytical Holding Time
Nitrite-N/ Nitrate-N	EPA 353.1, MCAWW	One 500-mL polyethylene container	Two 500-mL polyethylene containers	Preserve with H_2SO_4.	48 hours
Sulfate/Chloride	EPA 300.0	One 500-mL polyethylene container	Two 500-mL polyethylene containers	Unpreserved. Cool to 4°C.	28 days
Carbonate	SM 2320, SMEWW	One 1-L polyethylene container	Not applicable	Unpreserved. Cool to 4°C.	14 days
TDS	EPA 160.1, MCAWW	One 1-L polyethylene container	One 1-L polyethylene container	Unpreserved. Cool to 4°C.	7 days
Methane/ethane/ ethene	RSK-175	Two 40-mL VOC vials	Three 40-mL VOC vials	Sample must be collected without headspace. Preserve with HCl to pH ≤ 2 and cool to 4°C.	14 days (7 days if unpreserved)
Salinity	SM 2520B	One 1-L polyethylene container	One 1-L polyethylene container	Unpreserved. Cool to 4°C.	28 days
Field Measurements					
Dissolved Oxygen	Water quality meter(2,3)	Not applicable	Not applicable	Limit introduction of atmospheric oxygen during measurement	Analyze immediately
Oxidation-Reduction Potential	Water quality meter(2)	Not applicable	Not applicable	Time sensitive	Analyze immediately
pH	Water quality meter(2)	Not applicable	Not applicable	Time sensitive	Analyze immediately

TABLE 2-1

GROUNDWATER ANALYTICAL PROTOCOL
PHASE 1 GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 3 of 3)

Analysis	Method/ Reference	Sample Volume, Container	Extra MS/MSD Volume	Preservation	Analytical Holding Time
Specific Conductance	Water quality meter$^{(2)}$	Not applicable	Not applicable	Time sensitive	Analyze immediately
Temperature	Water quality meter$^{(2)}$	Not applicable	Not applicable	Time sensitive	Analyze immediately
Turbidity	Water quality meter$^{(4)}$	Not applicable	Not applicable	Time sensitive	Analyze immediately
Iron (II)	Hach method 8149, Color disc/PAN	One 50-mL glass container	One 50-mL glass container	Filter if turbid. Keep out of sunlight.	Analyze immediately

Notes:
(1) 7 days to extraction, 40 days from extraction to analysis .
(2) Field data to be measured with MicroPurge Flowcell 4000 or equivalent.
(3) Dissolved oxygen also to be initially measured with YSI 55 meter or equivalent.
(4) Turbidity data to be measured with a Horiba U10 or equivalent.

Filtering: Dissolved metals samples will be filtered in the field with a 0.45 micron filter before preservation. Hexavalent chromium samples will be filtered in the laboratory.

HCl Hydrochloric acid
HNO_3 Nitric acid
MCAWW Method for Chemical Anaysis of Water and Wastes
MS/MSD Matrix spike/matrix spike duplicate. Identified volumes to be collected in addition to those for the original sample.
RSK Risk Management Policies and Procedures Manual
SMEWW Standard Method for the Examination of Water and Wastewater

TABLE 2-2

COMPARISON OF DETECTION LIMITS AND ANALYTE SCREENING CRITERIA
PHASE 1 GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Compound	MCL (µg/L)	HGAL (µg/L)	NAWQC (µg/L)	Laboratory Reporting Limit (µg/L)	LRL Below Criterion?
Volatile Organic Compounds					
1,1,1-Trichloroethane	200	NA	NA	2	Yes
1,1,2,2-Tetrachloroethane	1	NA	NA	1	Yes (1)
1,1,2-Trichloroethane	5	NA	NA	2	Yes
1,1-Dichloroethane	5	NA	NA	2	Yes
1,1-Dichloroethene	6	NA	NA	2	Yes
1,2-Dichlorobenzene	600	NA	NA	2	Yes
1,2-Dichloroethane	0.5	NA	NA	0.5	Yes (1)
1,2-Dichloropropane	5	NA	NA	2	Yes
1,4-Dichlorobenzene	5	NA	NA	2	Yes
Benzene	1	NA	NA	0.5	Yes
Carbon tetrachloride	0.5	NA	NA	0.5	Yes (1)
cis-1,2-Dichloroethene	6	NA	NA	2	Yes
Methylene chloride	5	NA	NA	2	Yes
Tetrachloroethene	5	NA	NA	2	Yes
Trichloroethene	5	NA	NA	2	Yes
Vinyl chloride	0.5	NA	NA	0.5	Yes (1)
Semivolatile Organic Compounds					
Benzo(a)pyrene	0.2	NA	NA	0.1	Yes
Hexachloroethane	4.8 (2)	NA	NA	1.0	Yes
Pentachlorophenol	1	NA	NA	2.5	No (3)

TABLE 2-2

COMPARISON OF DETECTION LIMITS AND ANALYTE SCREENING CRITERIA
PHASE 1 GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 3)

Compound	MCL (µg/L)	HGAL (µg/L)	NAWQC (µg/L)	Laboratory Reporting Limit (µg/L)	LRL Below Criterion?
Polychlorinated Biphenyls/Pesticides					
Aroclor-1260	0.5 (4)	NA	0.19 (5)	0.1	Yes
Heptachlor epoxide	0.01	NA	NA	0.01	Yes (1)
Metals					
Antimony	6	43.3	500	2.7	Yes
Arsenic	50	27.3	36	1.9	Yes
Barium	1,000	504	NA	5.6	Yes
Beryllium	4	1.40	NA	0.2	Yes
Cadmium	5	5.08	9.3	0.3	Yes
Chromium	50	15.7	NA	0.9	Yes
Chromium (VI)	109 (1)	NA	NA	10	Yes
Cobalt	NA	20.8	NA	2.0	Yes
Copper	1,300	28.0	2.4	1.7	Yes
Lead	15	14.4	8.1	1.0	Yes
Manganese	NA	8,140	NA	0.4	Yes
Mercury	2	0.60	0.03	0.1	Yes
Nickel	100	96.5	8.2	1.7	Yes
Silver	NA	7.43	0.92	1.9	Yes
Thallium	2	13.0	NA	2.7	Yes (6)
Zinc	NA	75.7	81	1.6	Yes
Total Petroleum Hydrocarbons					
TPH-p	NA	NA	NA	50	NA
TPH-e	NA	NA	NA	100	NA

TABLE 2-2

COMPARISON OF DETECTION LIMITS AND ANALYTE SCREENING CRITERIA
PHASE 1 GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 3 of 3)

Compound	MCL (µg/L)	HGAL (µg/L)	NAWQC (µg/L)	Laboratory Reporting Limit (µg/L)	LRL Below Criterion?
Anions					
Chloride	NA	NA	NA	500	NA
Nitrate-N	NA	NA	NA	100	NA
Nitrite-N	NA	NA	NA	100	NA
Sulfate	NA	NA	NA	500	NA
Carbonate	NA	NA	NA	20,000 µg/L calcium carbonate	NA
Other					
Total Dissolved Solids	NA	NA	NA	10,000	NA

Notes:

(1) LRL is equal to the applicable criterion; since the method detection limit for each analyte is at or below the reporting limit, detected or nondetected results reported at the reporting limit should be reliable. Further, the laboratory reports results down to one-half the reporting limit, if the analyte is detected in the sample.
(2) Tap water preliminary remediation goal (US Environmental Protection Agency, Region IX, 1999)
(3) LRL is lowest practical reporting limit; further, the laboratory reports results down to one-half the reporting limit, if the analyte is detected in the sample.
(4) MCL for total PCBs
(5) Great Lakes Water Quality Initiative, Tier II criterion
(6) HGAL is the applicable criterion for thallium

HGAL HPS groundwater ambient levels for metals in A-aquifer groundwater
LRL Laboratory report limit
MCL Maximum contaminant level (from most stringent of federal or state primary MCL)
NA Not applicable
NAWQC National Ambient Water Quality Criteria for protection of saltwater aquatic life, based on continuous concentrations with a 4-day average
PCB Polychlorinated biphenyls
TPH-g Total petroleum hydrocarbons, purgeable (gasoline)
TPH-e Total petroleum hydrocarbons, extractables (diesel and motor oil)
WPCP Water pollution control plant
µg/L Micrograms per liter

APPENDIX 3

PRECISION AND ACCURACY GOALS

TABLE 3-1

VOLATILE ORGANIC COMPOUNDS
CONTRACT LABORATORY PROGRAM METHOD
PRECISION AND ACCURACY GOALS
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA
(Page 1 of 1)

Laboratory and Matrix Spike Limits

Fraction	Spike Compound	% Recovery	RPD
VOC	1,1-Dichloroethene	61-145	14
VOC	Trichlorethene	71-120	14
VOC	Chlorobenzene	75-130	13
VOC	Toluene	76-125	13
VOC	Benzene	76-127	11

Surrogate Recovery Limits

Fraction	Surrogate Compound	% Recovery
VOC	Toluene-d_8	88-110
VOC	4-Bromofluorobenzene	86-115
VOC	1,2-Dichloroethane-d_4	76-114

Notes:

RPD Relative percent difference

VOC Volatile organic compound

TABLE 3-2

SEMIVOLATILE ORGANIC COMPOUNDS
CONTRACT LABORATORY PROGRAM METHOD
PRECISION AND ACCURACY GOALS
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA
(Page 1 of 1)

Laboratory and Matrix Spike Limits

Fraction	Spike Compound	% Recovery	RPD
Base/Neutral	1,2,4-Trichlorobenzene	39-98	28
Base/Neutral	Acenaphthene	46-118	31
Base/Neutral	2,4-Dinitrotoluene	24-96	38
Base/Neutral	Pyrene	26-127	31
Base/Neutral	N-Nitroso-di-n-propylamine	41-116	38
Base/Neutral	1,4-Dichlorobenzene	36-97	28
Acid	Pentachlorophenol	9-103	50
Acid	Phenol	12-110	42
Acid	2-Chlorophenol	27-123	40
Acid	4-Chloro-3-methylphenol	23-97	42
Acid	4-Nitrophenol	10-80	50

Surrogate Recovery Limits

Fraction	Surrogate Compound	% Recovery
Base/Neutral	Nitrobenzene-d_5	35-114
Base/Neutral	2-Fluorobiphenyl	43-116
Base/Neutral	p-Terphenyl-d_{14}	33-141
Base/Neutral	1,2-Dichlorobenzene-d_4	16-110
Acid	Phenol-d_5	10-110
Acid	2-Fluorophenol	21-110
Acid	2,4,6-Tribromophenol	10-123
Acid	2-Chlorophenol-d_4	33-110

Notes:

RPD Relative percent difference

TABLE 3-3

**PESTICIDES AND POLYCHLORINATED BIPHENYLS
CONTRACT LABORATORY PROGRAM METHOD
PRECISION AND ACCURACY GOALS
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA
(Page 1 of 1)**

Laboratory and Matrix Spike Limits

Fraction	Spike Compound	% Recovery	RPD
Pest/PCB	gamma-BHC	56-123	15
Pest/PCB	Heptachlor	40-131	20
Pest/PCB	Aldrin	40-120	22
Pest/PCB	Dieldrin	52-126	18
Pest/PCB	Endrin	56-121	21
Pest/PCB	4,4'-DDT	38-127	27
Pest/PCB	Aroclor-1260	50-150	50

Surrogate Recovery Limits

Fraction	Surrogate Compound	% Recovery
Pest/PCB	Tetrachloro-m-xylene	30-150
Pest/PCB	Decachlorobiphenyl	30-150

Notes:

PCB Polychlorinated biphenyl

RPD Relative Percent difference

TABLE 3-4

MISCELLANEOUS ORGANIC ANALYSES
PRECISION AND ACCURACY GOALS
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

Analyses	Method	Laboratory / Matrix Spike		Surrogates
		% Recovery	RPD	% Recovery
Total Petroleum Hydrocarbons-Purgeable	EPA 8015B	70-130	30	75-125
Total Petroleum Hydrocarbons-Extractable	EPA 8015B (silica gel cleanup optional)	50-150	50	60-140

Notes:

EPA U.S. Environmental Protection Agency
RPD Relative percent difference

TABLE 3-5

**INORGANIC ANALYSES
PRECISION AND ACCURACY GOALS
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA
(Page 1 of 1)**

Analyses	Method	% Recovery[a]	RPD[b]
Metals, Dissolved	CLP SOW	75-125	20
Hexavalent Chromium	EPA 7196A	75-125	20
Anions: Chloride, Nitrate-N, Nitrite-N, Sulfate	EPA 300.0	75-125	20
Carbonate	SM 2320	NA	10
Total Dissolved Solids	EPA 160.1	75-125	20

Notes:

CLP	Contract Laboratory Program
EPA	U.S. Environmental Protection Agency
NA	Not applicable
RPD	Relative percent difference
SM	Standard Methods for the Examination of Water and Wastewater
SOW	Statement of work
a	Percent recovery control limit is based on spiked sample
b	Relative percent difference control limit is based on duplicate sample

Prepared for

DEPARTMENT OF THE NAVY
Southwest Division
Naval Facilities Engineering Command
San Diego, California
Lead Remedial Project Manager:David DeMars

Prepared by

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Project Manager:Doug Bielskis

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APPENDIX B

FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN ADDENDA FOR PHASE II GROUNDWATER DATA GAPS INVESTIGATION HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA (dated January 8, 2001, provided on CD-ROM only)

Comprehensive Long-Term Environmental Action Navy (CLEAN II)

Contract # N62474-94-D-7609 · Contract Task Order 0011

Field Sampling Plan and Quality Assurance Project Plan Addenda for Phase II Groundwater Data Gaps Investigation

Hunters Point Shipyard
San Francisco, California

DS.0011.15702

January 8, 2001

Department of the Navy • Southwest Division

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Order 011

Prepared for

DEPARTMENT OF THE NAVY
Southwest Division
Naval Facilities Engineering Command
San Diego, California

FIELD SAMPLING PLAN ADDENDUM FOR PHASE II GROUNDWATER DATA GAPS INVESTIGATION

HUNTERS POINT SHIPYARD SAN FRANCISCO, CALIFORNIA

DS.0011.15702

January 8, 2001

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FOR

Tong Li, Ph.D., Project Manager

Mike Wanta, PE, Installation Coordinator

FIELD SAMPLING PLAN ADDENDUM
FOR PHASE II GROUNDWATER DATA GAPS INVESTIGATION

HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

Prepared for:

DEPARTMENT OF THE NAVY

REVIEW AND APPROVALS

TtEMI Project Manager: ______ FOR Date: 12/29/00
Tong Li
TtEMI Seattle

TtEMI Program
Quality Assurance Manager: Greg Swanson Date: 1/3/01
Gregory Swanson
TtEMI San Diego

Navy Quality Assurance Officer: Narciso Allan Ancog Date: 1/4/01
Narciso Ancog

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ABBREVIATIONS AND ACRONYMS

BCT	Base Realignment and Closure Cleanup Team
BRAC	Base Realignment and Closure
CLEAN	Comprehensive Long-term Environmental Action Navy Contract
CLP	Contract Laboratory Program
CTO	Contract task order
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
Fe2+	Ferrous iron
Fe3+	Ferric iron
FID	Flame ionization detector
FS	Feasibility study
FSP	Field sampling plan
GDGI	Groundwater data gaps investigation
HCl	Hydrochloric acid
HPS	Hunters Point Shipyard
HSP	Health and safety plan
ID	Identification
IDW	Investigation-derived waste
Mn2+	Manganese (II)
MNA	Monitored natural attenuation
mg/L	Milligrams per liter
Navy	U.S. Department of the Navy
$NaHSO_4$	Sodium bisulfate
PCB	Polychlorinated biphenyl
PID	Photoionization detector
PPE	Personal protective equipment
PRC	PRC Environmental Management, Inc.
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
RI	Remedial investigation
RU	Remedial unit
SAP	Sampling and analysis plan
SOP	Standard operating procedure

ABBREVIATIONS AND ACRONYMS (Continued)

SOW	Scope of work
SVOC	Semivolatile organic compound
SWDIV	Naval Facilities Engineering Command, Southwest Division
TDS	Total dissolved solids
TIZ	Tidally influenced zone
TPH	Total petroleum hydrocarbons
TPH-e	TPH-extractables
TPH-p	TPH-purgeables
TtEMI	Tetra Tech EM Inc.
VOC	Volatile organic compound

1.0 INTRODUCTION

Tetra Tech EM Inc. (TtEMI) received contract task orders (CTO) 005 and 011 under Comprehensive Long-term Environmental Action Navy Contract No. N62474-94-D-7609 (CLEAN II) from the Department of the Navy (Navy), Naval Facilities Engineering Command, Southwest Division (SWDIV) to conduct a remedial investigation (RI) through record-of-decision activities at Parcels D and E (CTO 005) and Parcels B and C (CTO 011) at Hunters Point Shipyard (HPS), San Francisco, California. TtEMI received subsequent modifications of CTOs 005 and 011 for the evaluation of groundwater data gaps.

A phased approach is being used in the implementation of the current groundwater data gaps investigation (GDGI). The Phase I GDGI was conducted at Parcels C and D at HPS from July 2000 to December 2000. The Phase I GDGI was conducted in accordance with the associated planning document titled "Final Field Sampling Plan and Quality Assurance Project Plan for Phase I Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California," dated July 31, 2000 (TtEMI 2000a, see also Appendix A of this FSP addendum). The scope of work (SOW) for the Phase II GDGI will include sampling of the groundwater monitoring wells at Parcels C and D sampled or installed during the Phase I GDGI. The Phase II GDGI SOW will also include sampling of existing groundwater monitoring wells at Parcel E at HPS. Development of the SOW for the Phase II GDGI is based on input from the HPS Base Realignment and Closure (BRAC) Cleanup Team (BCT), provided during two working meetings conducted in November and December 2000 (SWDIV 2000a, 2000b). Minutes of those working meetings are included in this document as Appendix B. Appendix B also contains data summary tables used during the Parcel E groundwater meeting on November 7, 2000, and a summary of the rationale for identifying Parcel E groundwater data gaps. The results of the Phase I GDGI were summarized in a document titled "Information Package for the Phase I Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California," dated December 1, 2000. To address concerns discussed during the December 5, 2000 working meeting, a revised Phase I GDGI information package will be submitted on January 8, 2000.

This FSP addendum is a supplement to the "Final Field Sampling Plan and Quality Assurance Project Plan for Phase I Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California" dated July 31, 2000 (TtEMI 2000a, see also Appendix A of this FSP addendum) and approved by the Navy on July 25, 2000. All changes in the Phase I GDGI SOW for the Phase II GDGI are set forth in detail in this field sampling plan (FSP) addendum. However, for brevity, sections of the Phase I GDGI

FSP to which no changes have been made are not included in this FSP addendum. The sections to which no changes have been made instead are noted in the text of the FSP addendum as having "no change."

This FSP addendum (and the FSP for the Phase I GDGI) provides specific details about the methods to be used for sample collection, the location and number of samples to be collected, field quality control (QC) procedures, sampling and handling procedures, and shipping. A quality assurance project plan (QAPP) addendum has also been developed to supplement this document. The QAPP addendum (and the QAPP for the Phase I GDGI) fully describes the project data quality objectives (DQO), which have been developed through the seven-step DQO process (U.S. Environmental Protection Agency [EPA] 1999), according to EPA guidance for preparation of QAPPs (EPA 1998). This FSP addendum, along with the accompanying QAPP addendum, make up the sampling and analysis plan (SAP) addendum; field crews are expected to have both the QAPP and the FSP addenda on hand at all times (in addition to the FSP and QAPP for the Phase I GDGI). Both documents are provided in a single binder for easy reference. A summary of the site background and the results of previous investigations are presented in the accompanying QAPP. A more detailed discussion of background and an analysis of site information are presented in the Parcels B, C, D, and E RI reports (PRC Environmental Management, Inc. [PRC] 1996a, 1997a, 1996b, and 1997b, respectively) and the feasibility study (FS) reports (PRC 1996c; TtEMI 1998a; PRC 1997c; and TtEMI 1998b, respectively). Data collection and measurement activities set forth in detail in this FSP addendum will be conducted in accordance with TtEMI's "CLEAN II Program Health and Safety Plan (HSP), Revision I" (PRC 1995) and the basewide HSP (TtEMI 2000b).

Section 2.0 of this FSP addendum describes the purpose and objectives of the investigation. Section 3.0 provides information about the site location and background. Section 4.0 provides specific details about proposed field methods and field procedures. Section 5.0 presents the procedures to be used in collecting and handling field quality assurance (QA) and QC samples. Section 6.0 provides procedures for handling and shipment of samples and chain of custody. Section 7.0 outlines the health and safety concerns and requirements for the investigation and provides references to the basewide HSP. Section 8.0 presents the schedule for the Phase II GDGI. Section 9.0 summarizes the reporting of the Phase II GDGI results. Section 10.0 lists all references cited in this document. Tables, figures, and appendices are presented after the text and references.

2.0 PURPOSE AND OBJECTIVE

The purpose and objectives of this investigation, as well as the chronology of events leading to the Phase II GDGI, are more fully described in the accompanying QAPP addendum. The overall project objective of the GDGI is to resolve the following data gaps: (1) most monitoring wells throughout HPS have not been sampled in more than four years, and their conditions are unknown; (2) the most current basewide A-aquifer potentiometric surface map was generated more than four years ago and therefore may not reflect current groundwater flow conditions; (3) the extent of contamination in the B-aquifer and its relationship to the A-aquifer at Parcels C, D, and E (and potentially at a portion of Parcel B) have not been evaluated because chemical and hydrogeologic data are insufficient to support an evaluation; and (4) existing A-aquifer and bedrock water-bearing zone ecological and human health remedial units (RU) at Parcels C, D, and E were developed on the basis of chemical data collected more than four years ago. Note that groundwater data gaps have been identified at Parcel E on the basis of the results of a working meeting with the BCT similar to the working meetings conducted for Parcels C and D.

The specific purpose of this FSP is to describe in detail the four discrete tasks that have been or will be performed under the Phase I GDGI to address the data gaps listed above: (1) assess the condition of all existing wells (completed); (2) measure basewide water levels to determine the potentiometric surface at existing A- and B-aquifer wells; (3) perform additional characterization of the B-aquifer in Parcels C, D, and E by sampling existing and newly installed wells for hydrogeologic (including yield, hydraulic conductivity, horizontal gradient, and vertical gradient) and chemical parameters; and (4) resample A-aquifer wells in Parcels C, D, and E for chemical parameters to characterize the extent of contamination. The conditions of all existing wells at HPS were evaluated in April 2000, and basic maintenance has been conducted through November 2000; the results of that evaluation have been incorporated into this FSP addendum. Tasks 3 and 4 will include the collection of data on total dissolved solids (TDS) at all wells sampled during the Phase II GDGI. The TDS data will aid in refining or confirming the areas that meet the federal and state drinking-water criteria of 10,000 and 3,000 milligrams per liter (mg/L), respectively.

The Phase II GDGI is the second phase of the investigation intended to resolve the data gaps previously discussed. The third phase of the GDGI will involve a third round of sampling at Parcel C and a second round of sampling at Parcel E; no Phase III sampling is anticipated at Parcel D. The Phase III GDGI will incorporate the data gathered during the first two phases of the investigation; the number of monitoring wells may increase or decrease, as deemed appropriate following an evaluation of the initial data. The FSP and the accompanying QAPP for the Phase I GDGI will be amended to be applicable to subsequent phases of the GDGI.

3.0 SITE LOCATION AND BACKGROUND

No change.

3.1 FACILITY LOCATION

No change.

3.2 FACILITY BACKGROUND

No change.

4.0 FIELD METHODS AND PROCEDURES

The following sections provide details about procedures and methods to be used in the field. Activities described in the following subsections include monitoring well inspections (Section 4.1), water level measurement (Section 4.2), groundwater sampling (Section 4.3), well installation (Section 4.4), well development (Section 4.5), field equipment calibration (Section 4.6), decontamination (Section 4.7), and investigation-derived waste (IDW) management (Section 4.8).

4.1 MONITORING WELL INSPECTIONS

The Navy conducted a basewide monitoring well inspection survey in April 2000. During the inspection, the Navy completed light maintenance of monitoring wells, including replacement of malfunctioning well caps and locks, replacement of missing lid bolts, and renewal of the water-level measurement mark or notch and external well identification information. The Navy recorded all well inspection information and noted recommended repairs, when necessary, on monitoring well inspection forms (Appendix 1, QAPP). Table 4-1 of this FSP presents the results of the well inspection survey.

Figure 4-1 shows the locations of monitoring wells. At each monitoring well, the inspection evaluated:

- Condition of external well identification information
- Condition of the concrete pad and adjacent area
- Condition of the well vault, lid, rubber seal, and lid bolts or well stickup and riser standpipe
- Presence of standing water (precipitation or other) in the vault
- Location of the vault in relation to the adjacent ground surface (for example, whether the grade encourages drainage toward the well vault)
- Condition of the internal well identification tag
- Condition of the well lock and well cap

- Condition of the water-level measuring mark or notch
- Condition of the well casing

Measurements of water level and total depth were also collected at each monitoring well. On the basis of the results of the well inspection survey, the Navy performed the following activities during the Phase I GDGI: (1) replacement of several damaged surface well vaults at HPS and (2) redevelopment of several wells in Parcel C before Phase I sampling. No further well repair activities are anticipated during the Phase II GDGI; however, additional well redevelopment activities will be conducted at Parcel E.

4.2 WATER LEVEL MEASUREMENT

Water levels will be measured at 202 A-aquifer wells and 39 B-aquifer wells basewide, as listed in Table 4-2 and shown on Figure 4-1. As noted on Table 4-2, 29 new wells installed during the Phase I GDGI (9 A-aquifer wells and 20 B-aquifer wells) have been added to the water level measurement event for the Phase II GDGI. In addition, 5 existing A-aquifer wells have been added to the Phase II GDGI water level measurement event. These wells have been included to provide additional data for the A-aquifer potentiometric surface map, and to evaluate the horizontal and vertical gradients in the B-aquifer. All water levels will be measured within a 4-hour period of relatively low tidal fluctuation. To collect groundwater levels at times when tidal fluctuation is minimal, the procedure described below will be followed:

- Approximately 14 persons will measure water levels in approximately 17 different wells over a period not exceeding 4 hours. This procedure will allow an average of approximately 15 minutes for each well measurement, including time of travel between wells.
- Before the measurement period begins, all well covers will be unlocked and unfastened to allow speedy access to the well during the measurement period.
- The measurement period will fall during a period of relatively low tidal fluctuation in San Francisco Bay.
- Measurement of groundwater levels will begin 1 hour before the high or low tide and will be completed in less than 4 hours (that is, no later than 3 hours after the high or low tide).

- During the measurement period, groundwater levels generally will be measured first in wells nearest the shore (that is, the locations expected to display the highest tidal efficiency). Water level measurement will proceed to wells farther from the shore (that is, the locations expected to display relatively lower tidal efficiencies), with the wells farthest from the shore measured last. This order of measurement of monitoring wells will minimize the effects of tidal fluctuation on the water levels because (1) wells that display the greatest degree of tidal fluctuation will be measured during a period when the rate of water level change as a result of tidal fluctuation is relatively low and (2) wells that display less tidal fluctuation will be measured during a period when the rate of water level change due to tidal fluctuation is relatively higher (but not as significant as that for wells closer to the shoreline).

Measurements of salinity and TDS at the A- and B-aquifer well pairs will also be collected to be used for vertical gradient correction. Measurements of water levels will be collected as set forth in TtEMI standard operating procedure (SOP) No. 14, "Revision No. 0, Static Water Level, Total Well Depth, and Immiscible Layer Measurement" (presented in Appendix C of FSP for Phase I GDGI), as amended in this section. Initial measurements of organic vapors and dissolved oxygen will be taken with a photoionization detector (PID) or flame ionization detector (FID) and a down-the-well probe, respectively, as discussed in Section 4.3.2 of this FSP. Accordingly, respiratory protection equipment will be immediately available to each team, but not necessarily worn while approaching each well. The field team will record all water-level measurements in field logbooks or on well inspection forms (Appendix 1, QAPP).

Because several years have passed since the initial well survey, top-of-casing elevations at 24 selected wells (as shown in Table 4-3) were measured during the Phase I GDGI to confirm previous survey measurements. In addition, top-of-casing and/or ground surface elevations were measured at approximately 65 wells for which survey data were incomplete, as detailed in Table 4-1. The data collected during the confirmation land survey varied from the historical survey data; therefore, further evaluation during the Phase I GDGI was warranted. The Navy resurveyed the top-of-casing elevations at the following wells: (1) all wells included in the water-level measurement event for the Phase I GDGI, (2) new wells installed during the Phase II GDGI, and (3) existing wells proposed for addition to the Phase II GDGI water level measurement event. No further survey work is anticipated for the Phase II GDGI.

4.3 GROUNDWATER SAMPLING

The following sections provide details about (1) sample locations, (2) initial measurement of organic vapors and dissolved oxygen, (3) sampling methods, and (4) sample analysis. Additional details about chemical analysis of groundwater and QC samples are provided in the accompanying QAPP.

4.3.1 Sample Locations

Groundwater samples will be collected from monitoring wells identified in Table 4-4 and on Figures 4-2 through 4-5, in accordance with the schedule presented in Section 8.0. The specific rationale for the sampling locations in Parcels C, D, and E is presented in Tables 4-5, 4-6, and 4-7, respectively. Monitoring wells within the tidally influenced zone (TIZ) (identified on Figures 4-1 through 4-5) will be sampled within a 4-hour period of relatively low tidal fluctuation to provide the optimum comparison with the results of sampling of other wells located outside the TIZ.

4.3.2 Initial Measurement of Organic Vapor and Dissolved Oxygen

No change.

4.3.3 Sampling Methods

No change.

4.3.4 Sample Analysis

As indicated in Table 4-4, samples from each well will be analyzed for the following site-specific analytes of concern: low-level EPA Contract Laboratory Program (CLP) volatile organic compounds (VOC); low-level CLP semivolatile organic compounds (SVOC); low-level CLP pesticides and polychlorinated biphenyls (PCB); CLP dissolved metals; total petroleum hydrocarbons-extractable (TPH-e); total petroleum hydrocarbons-purgeable (TPH-p); hexavalent chromium; gross alpha and beta radioactivity, radium 226 and 228, and monitored natural attenuation (MNA) parameters. MNA parameters include methane, ethane, ethene, ferrous iron (Fe2+), ferric iron (Fe3+), and manganese (II) (Mn2+), nitrate, nitrite, sulfate, dissolved oxygen, oxidation-reduction potential, chloride, total alkalinity, hydroxide alkalinity, carbonate, bicarbonate, calcium, magnesium, sodium, potassium, salinity, and TDS. Table 2-1 in Appendix 2 of the accompanying QAPP identifies the sample methods, containers, preservation, and holding times for all constituents to be analyzed for in groundwater samples. Section 6.1 of the FSP for the Phase I GDGI describes the sample identification (ID) system (the sample ID system is unchanged).

Sample bottles will be filled in accordance with the provisions of TtEMI SOP No. 10, Revision 3, “Groundwater Sampling,” as amended below. Summarized below is the order in which samples will be collected:

1. Collect samples for analysis for CLP VOCs, methane, ethane, ethene, and TPH-p in containers, as listed in Table 2-1, Appendix 2 of the accompanying QAPP. Samples for those

parameters must be collected with zero headspace in the vial. After sealing the sample to be analyzed, invert the vial and inspect it for air bubbles. If air bubbles are present, the sample must be discarded and the groundwater resampled.

In cases in which the groundwater reacts with the hydrochloric acid (HCl) preservative in the containers and collection of a preserved sample without bubbles is prevented, it is acceptable to collect the VOC, methane, ethane, ethene, and TPH-p samples in unpreserved sample vials. Note on the field sheets and chain-of-custody records that the groundwater sample reacted with the HCl preservative and that an unpreserved sample was collected (since the holding time for the sample will be reduced). As an alternative, solid sodium bisulfate ($NaHSO_4$) may be used as a preservative, contingent upon the approval of the project chemist.

2. Collect the samples to be analyzed for other organics (SVOCs, TPH-e, pesticides, and PCBs). Fill amber bottles to the neck of the bottle.

3. Collect the samples to be analyzed for inorganics (metals, hexavalent chromium, gross alpha and beta radioactivity, radium 226 and 228, and remaining MNA parameters). Samples collected for analysis for dissolved metals will be filtered in the field, using disposable, high-capacity 0.45-micron filters. A Fisher Scientific filter (part number 12020) or equivalent will be used. Each sample to be analyzed for dissolved metals will be pumped through the filter using a peristaltic pump and Tygon tubing. New tubing and filters will be used for each sample to be analyzed for dissolved metals. Fill each preserved polyethylene sample bottle to the neck.

Immediately after samples have been collected, samples designated for off-site laboratory analysis will be transferred to a cooler maintained at 4 °C.

4.4 WELL INSTALLATION

During the Phase I GDGI, two additional A-aquifer monitoring wells (IR06MW59A1 and IR06MW59A2), one additional B-aquifer monitoring well (IR25MW42B), and one additional bedrock water-bearing-zone monitoring well (IR28MW402F) were drilled, installed, and developed in the Parcel C locations shown on Figure 4-5. In addition, one bedrock water-bearing zone monitoring well (IR28MW393F) was installed in place of a B-aquifer monitoring well because no B-aquifer sediments were present at that location. The additional wells were installed based on the preliminary findings of the Phase I GDGI and were discussed with the BCT during the working meeting on December 5, 2000. The specific rationale for installing the additional wells will be discussed in the revised Phase I GDGI information package, which is scheduled to be submitted on January 8, 2000. No well installation activities are anticipated at Parcels C, D, or E during the Phase II GDGI.

4.5 WELL DEVELOPMENT

No change.

4.6 FIELD CALIBRATION EQUIPMENT

No change.

4.7 DECONTAMINATION

No change.

4.7.1 Well Installation and Development

No change.

4.7.2 Groundwater Sampling

No change.

4.8 INVESTIGATION-DERIVED WASTE MANAGEMENT

No change.

5.0 FIELD QUALITY ASSURANCE AND QUALITY CONTROL SAMPLES

No change.

6.0 SAMPLE HANDLING, SHIPMENT, AND CHAIN OF CUSTODY

No change.

6.1 SAMPLE IDENTIFICATION AND LABELING

No change.

6.2 SAMPLE CONTAINERIZATION, PRESERVATION, AND HOLDING TIME

No change.

6.3 DOCUMENTATION

No change.

7.0 HEALTH AND SAFETY

A basewide HSP (TtEMI 2000b) was prepared for activities at HPS. The basewide HSP provides information about the physical, biological, and chemical hazards associated with the various field activities to be conducted during the investigation. The basewide HSP also provides a detailed discussion of anticipated health and safety concerns related to the investigation.

8.0 SCHEDULE

Table 8-1 provides the schedule for the HPS Phase II GDGI. The schedule relies on a number of assumptions that, when fully defined, may result in changes in or updates of the proposed schedule. Critical assumptions include those related to document review times.

9.0 REPORTING

Data on water levels and water quality gathered during the Phase II GDGI will be presented to the BCT in information packages for each parcel similar to the information package for the Phase I GDGI. Table 8-1 provides the schedule for submittal of the Phase II GDGI information packages for parcels C, D, and E. The BCT's evaluation of the information packages will be incorporated into the revised FSs for Parcels C, D, and E.

10.0 REFERENCES

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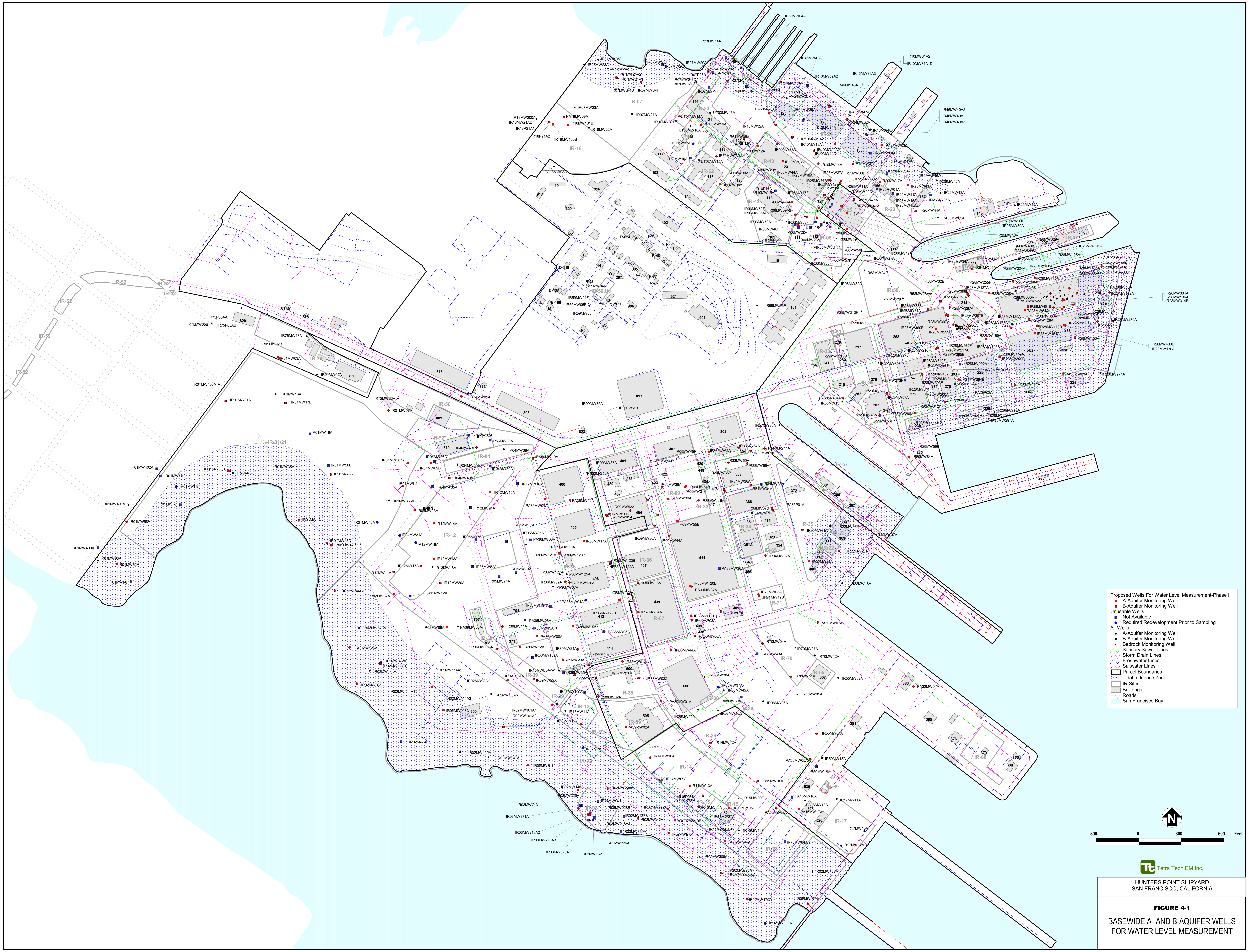
EPA. 1999. "Guidance for the Data Quality Objectives Process." Peer Review Draft. EPA QA/G-4. December.

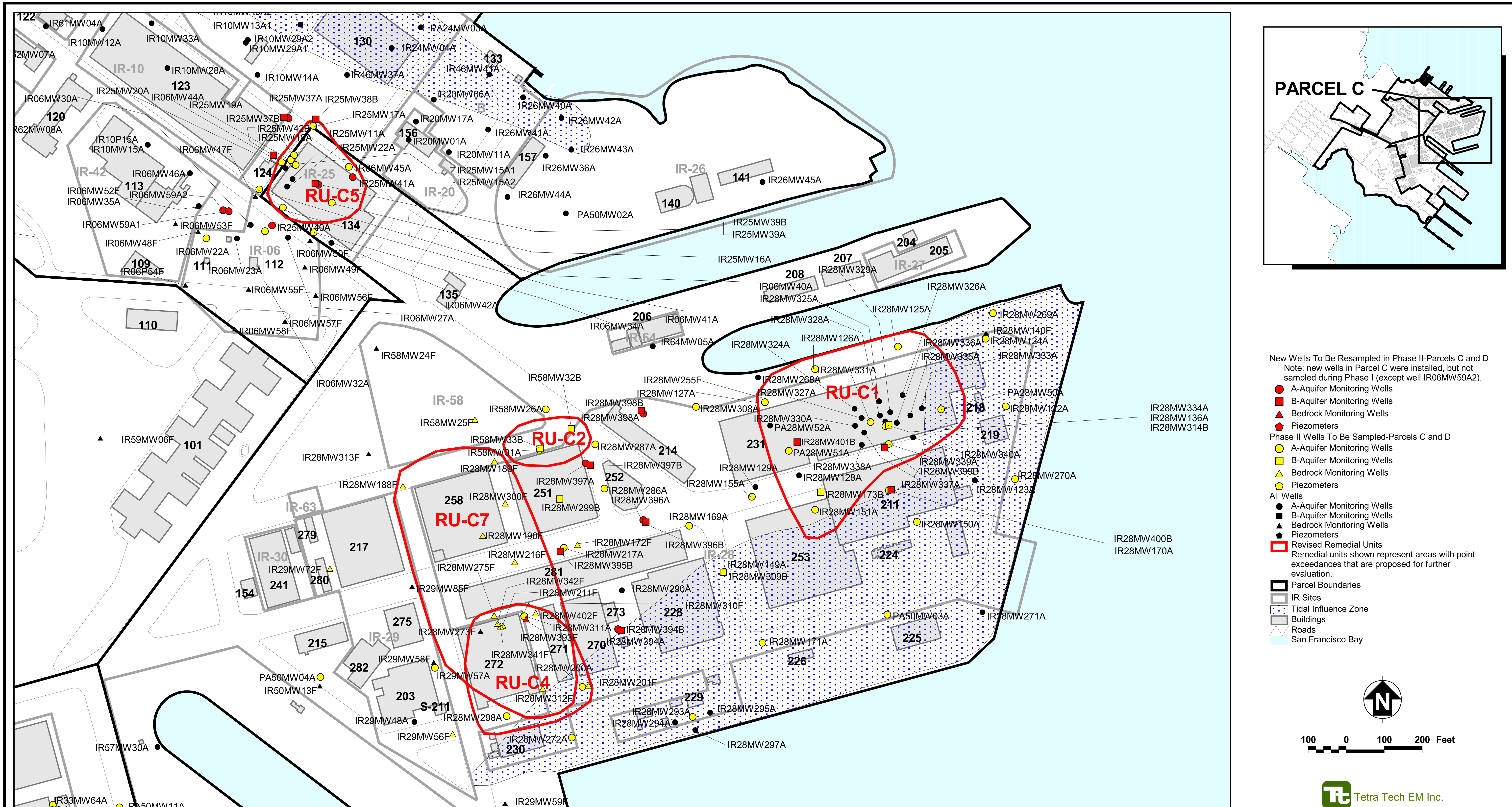
FIGURES



HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE 4-1

BASEWIDE A- AND B-AQUIFER WELLS FOR WATER LEVEL MEASUREMENT



HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE 4-2

PARCEL C
WELLS FOR RESAMPLING TO CONFIRM
EXTENT OF REMEDIAL UNITS

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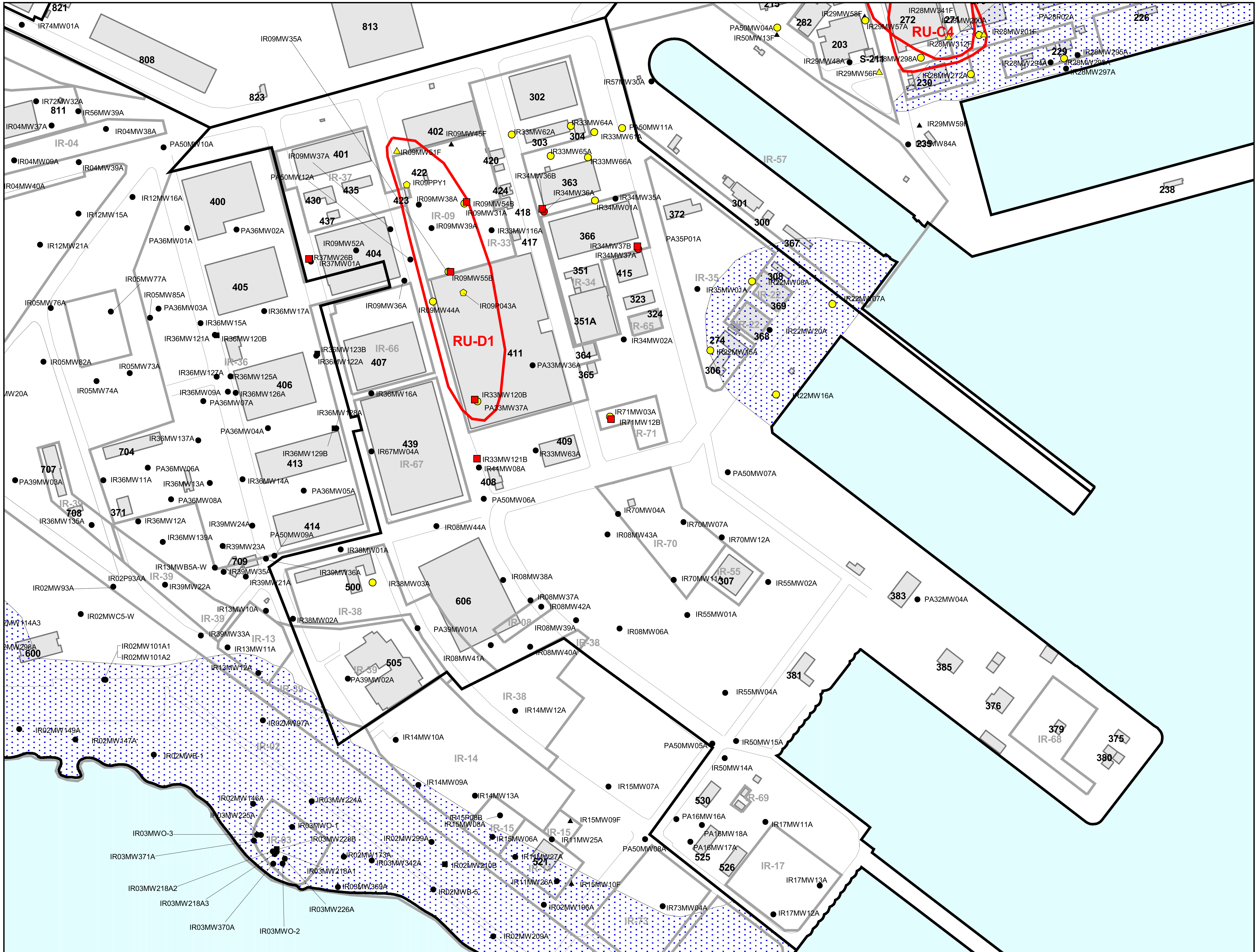

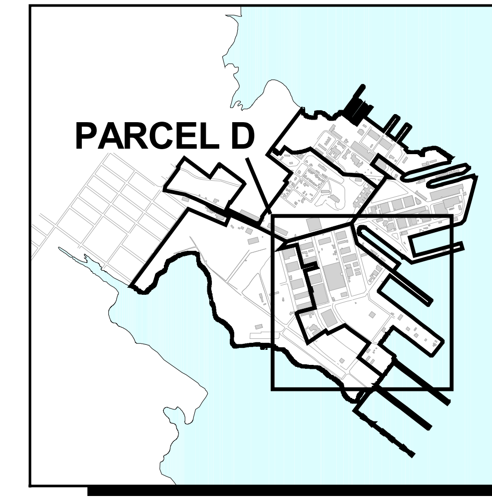

New Wells To Be Resampled in Phase II-Parcels C and D
Note: new wells in Parcel D were installed and sampled during Phase I.
- A-Aquifer Monitoring Wells
- B-Aquifer Monitoring Wells
- Bedrock Monitoring Wells
- Piezometers

Phase II Wells To Be Sampled-Parcels C and D
- A-Aquifer Monitoring Wells
- B-Aquifer Monitoring Wells
- Bedrock Monitoring Wells
- Piezometers

All Wells
- A-Aquifer Monitoring Wells
- B-Aquifer Monitoring Wells
- Bedrock Monitoring Wells
- Piezometers

Revised Remedial Units
Remedial units shown represent areas with point exceedances that are proposed for further evaluation.

Parcel Boundaries
IR Sites
Tidal Influence Zone
Buildings
Roads
San Francisco Bay

N

200 0 200 400 Feet

Tetra Tech EM Inc.

HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

FIGURE 4-3

PARCEL D
WELLS FOR RESAMPLING TO CONFIRM EXTENT OF REMEDIAL UNITS

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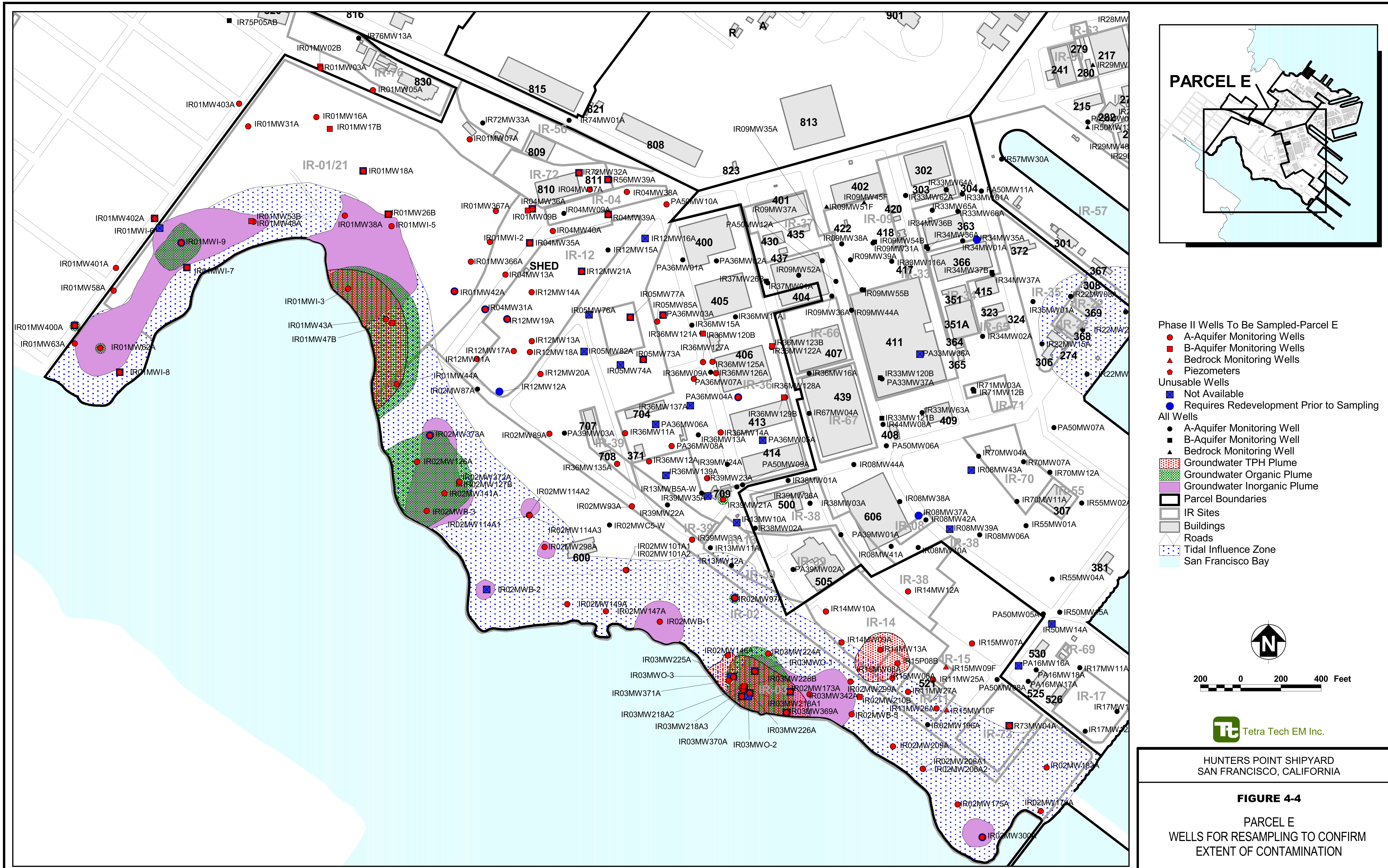

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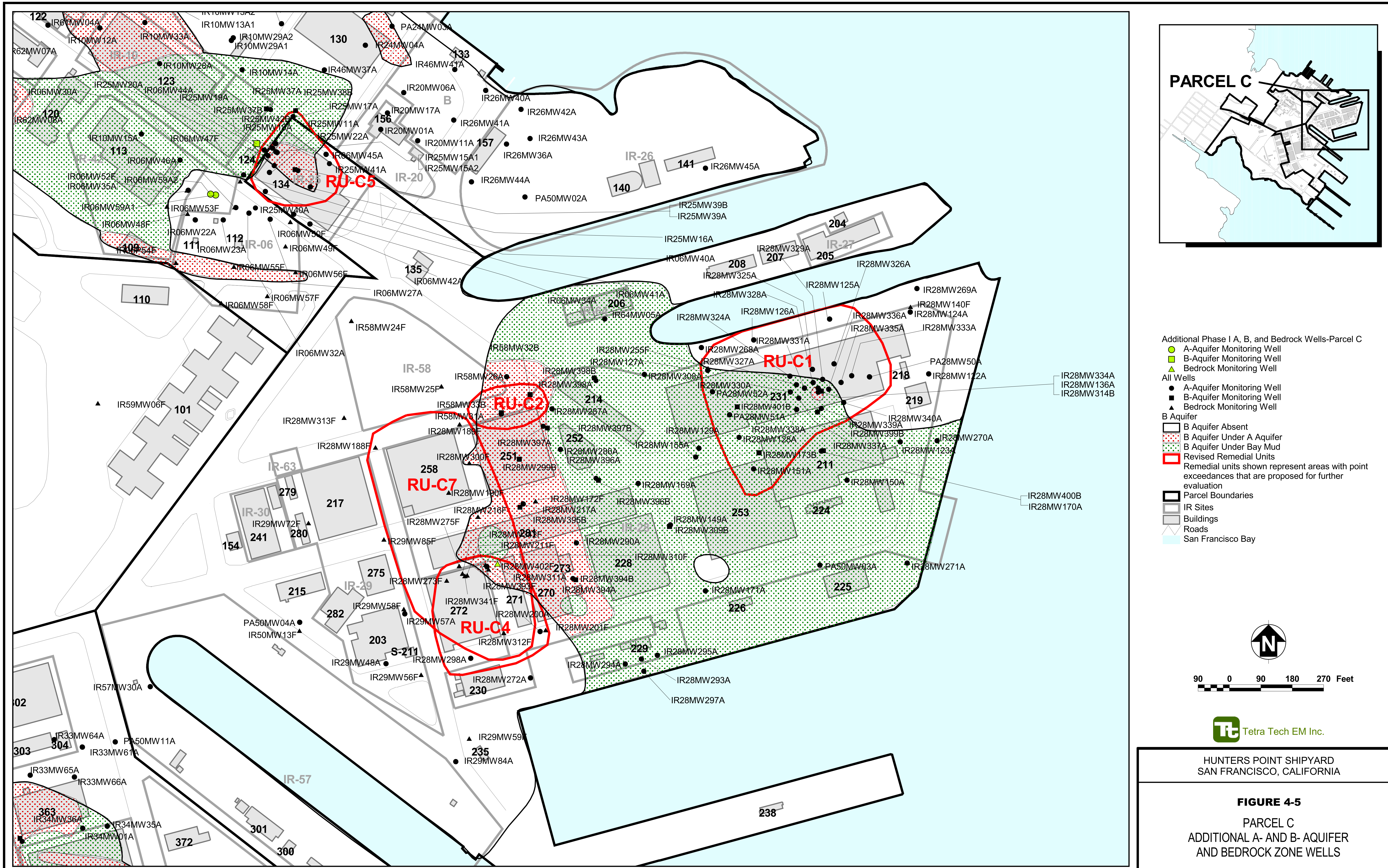

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TABLES

TABLE 4-1

RESULTS OF WELL CONDITION SURVEY
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

WELLS THAT REQUIRE REDEVELOPMENT BEFORE RESAMPLING				
IR Site	**Monitoring Well**			
PARCEL B				
IR-10	IR10MW13A2			
IR-62	UT02MW17A			
PARCEL D				
IR-08	IR08MW37A			
IR-09	IR09P043A*			
IR-34	IR34MW35A			
PARCEL E				
IR-01	IR01MW42A	IR01MWI-9		
IR-02	IR02MW300A	IR02MW373A	IR02MW97A	
IR-04	IR04MW31A			
IR-12	IR12MW12A	IR12MW19A		
IR-36	PA36MW04A			

Notes: Wells require redevelopment due to accumulated sediment within screened interval (between 10 and 50 percent of screened interval).

* Piezometer used for GDGI sampling will be redeveloped prior to Phase II GDGI sampling

Parcel C wells IR06MW45A, IR28MW309B, IR29MW58F, IR29MW84A, and IR58MW25F were redeveloped in June and July 2000 prior to Phase I GDGI sampling.

TABLE 4-1 (Continued)

RESULTS OF WELL CONDITION SURVEY
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 4)

WELLS THAT ARE NOT AVAILABLE FOR SAMPLING		
IR Site	**Monitoring Well**	
PARCEL B		
IR-06	IR06MW22A-D	Well is abandoned
	IR06MW23A	Well is abandoned
	IR06MW27A	Well is abandoned
	IR06MW30A	Well is abandoned
	IR06MW32A-D	Well is abandoned
	IR06MW48F	Well is abandoned
	IR06MW51F	Well is abandoned
IR-07	IR07MW20A2	Well is silted more than 50 percent
	IR07MWP-1	Well is abandoned
	IR07MWP-2	Well is abandoned
	IR07MWS-1	Well is abandoned
	IR07MWS-2D	Well is abandoned
	IR07MWS-3	Well is abandoned
	IR07MWS-4D	Well is abandoned
IR-10	IR10MW15A	Well is abandoned
	IR10MW31A2	Well is abandoned
IR-18	IR18MW21A	Well is abandoned
IR-20	IR20MW01A	Well is abandoned
	IR20MW06A	Well is abandoned
	IR20MW11A	Well is abandoned
IR-23	IR23MW14A	Well is abandoned
IR-24	IR24MW04A	Well is abandoned
	PA24MW03A-D	Well is abandoned
	PA24MW03A	Recently replaced well was damaged during recent remedial activities
IR-26	IR26MW36A	Well is abandoned
IR-46	IR46MW40A2	Well is abandoned
	IR46MW42A	Well is abandoned
IR-50	IR50MW14A	Well contains product
IR-60	IR60MW04A	Well is abandoned
	IR60MW10A	Well is abandoned
IR-62	UT02MW15A	Well contains product
	UT02MW16A	Well has been abandoned

TABLE 4-1 (Continued)

RESULTS OF WELL CONDITION SURVEY
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 3 of 4)

WELLS THAT ARE NOT AVAILABLE FOR SAMPLING		
IR Site	**Monitoring Well**	
PARCEL C		
IR-25	IR25MW11A	Well contains product
	IR25MW22A	Well contains product
IR-28	IR28MW129A	Well contains product
	IR28MW273F	Well is abandoned
	IR28MW290A	Well has not been located
	PA28MW52A	Well contains product
PARCEL D		
IR-08	IR08MW39A	Well is abandoned
	IR08MW43A	Well is abandoned
IR-16	PA16MW16A	Well is abandoned
IR-33	PA33MW36A	Well has not been located
IR-39	IR39MW35A	Well contains product
PARCEL E		
IR-01	IR01MW18A	Well contains product
	IR01MW26B	Well has not been located
	IR01MW400A	Lid of well could not be opened
	IR01MW402A	Well has not been located
	IR01MWI-6	Well has not been located
	IR01MWI-7	Lid of well could not be opened
	IR01MWI-8	Well is silted more than 50 percent
IR-02	IR02MW173A	Thick product was found in pipe
	IR02MWB-2	Well is abandoned
IR-03	IR03MW218A1	Well contains product
	IR03MW225A	Well contains product
	IR03MW226A	Well contains product
	IR03MW369A	Well contains product
	IR03MW370A	Well contains product
	IR03MWO-1	Well contains product
	IR03MWO-2	Well contains product
	IR03MWO-3	Well contains product

TABLE 4-1 (Continued)

RESULTS OF WELL CONDITION SURVEY
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 4 of 4)

WELLS THAT ARE NOT AVAILABLE FOR SAMPLING		
IR Site	**Monitoring Well**	
PARCEL E (Continued)		
IR-04	IR04MW35A	Well contains product
	IR04MW36A	Well contains product
	IR04MW39A	Well contains product
IR-05	IR05MW73A	Well contains product
	IR05MW74A	Well contains product
	IR05MW76A	Well has not been located
	IR05MW77A	Well contains product
	IR05MW82A	Well contains product
IR-12	IR12MW16A	Well contains product
	IR12MW21A	Well contains product
IR-13	IR13MW10A	Well has not been located
IR-36	IR36MW137A	Well is dry and access is obstructed
	IR36MW139A	Well has not been located
	PA36MW03A	Well is silted more than 50 percent
	PA36MW06A	Well has not been located
IR-56	IR56MW39A	Well contains product
IR-72	IR72MW32A	Well contains product
IR-73	IR73MW04A	Well contains product

Note:

IR Installation Restoration

TABLE 4-2

WELLS FOR WATER LEVEL MEASUREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well			
PARCEL B				
IR-06	IR06MW22A IR06MW59A1*	IR06MW32A	IR06MW35A	IR06MW46A
IR-07	IR07MW19A IR07MWS-4	IR07MW20A1	IR07MW21A1	IR07MW21A2
IR-10	IR10MW12A IR10MW29A1	IR10MW13A1 IR10MW32A	IR10MW14A IR10MW33A	IR10MW28A
IR-18	IR18MW21A	IR18MW100B	IR18MW101B	
IR-20	IR20MW17A			
IR-23	UT03MW11A	UT03MW12A		
IR-24	PA24MW02A	PA24MW03A		
IR-26	IR26MW41A	IR26MW44A		
IR-46	IR46MW37A	IR46MW38A	IR46MW39A	IR46MW43A
IR-50	PA50MW01A			
IR-61	IR61MW05A			
IR-62	IR62MW07A	IR62MW08A		
PARCEL C				
IR-25	IR06MW40A IR06MW45A IR25MW37B* IR25MW42B*	IR06MW41A IR25MW16A IR25MW38B*	IR06MW42A IR25MW17A IR25MW39A*	IR06MW44A IR25MW37A* IR25MW39B*
IR-28	IR28MW122A IR28MW123A IR28MW124A IR28MW125A IR28MW126A IR28MW128A IR28MW136A IR28MW299B IR28MW339A** IR28MW396A* IR28MW398A* IR28MW401B*	IR28MW149A IR28MW150A IR28MW151A IR28MW155A IR28MW169A IR28MW170A IR28MW171A IR28MW173B IR28MW394A* IR28MW396B* IR28MW398B*	IR28MW200A IR28MW217A IR28MW268A IR28MW286A IR28MW287A IR28MW298A IR28MW308A IR28MW309B IR28MW394B* IR28MW397A* IR28MW399B*	IR28MW311A IR28MW324A IR28MW326A IR28MW333A IR28MW338A IR28MW340A IR28MW314B PA28MW51A IR28MW395B* IR28MW397B* IR28MW400B*

TABLE 4-2 (Continued)

WELLS FOR WATER LEVEL MEASUREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 3)

IR Site	Monitoring Well			
PARCEL C (continued)				
IR-29	IR29MW48A	IR29MW57A	IR29MW84A	
IR-50	PA50MW03A	IR50MW04A		
IR-58	IR58MW26A	IR58MW31A	IR58MW32B	IR58MW33B
IR-64	IR64MW05A			
PARCEL D				
IR-08	IR08MW44A			
IR-09	IR09MW35A IR09MW36A IR09MW54B*	IR09MW37A IR09MW38A IR09MW55B*	IR09MW39A IR09MW44A	IR09MW52A IR09MW31A**
IR-16	PA16MW17A			
IR-22	IR22MW20A	IR22MW15A**		
IR-32	PA32MW04A			
IR-33	IR33MW116A IR33MW61A IR33MW120B*	IR33MW62A IR33MW63A IR33MW121B*	IR33MW64A IR33MW65A	IR33MW66A PA33MW37A
IR-34	IR34MW01A IR36MW37A*	IR34MW02A IR36MW37B*	IR34MW36A*	IR34MW36B*
IR-35	IR35MW01A			
IR-36	IR36MW16A			
IR-37	IR37MW01A	IR37MW26B*		
IR-38	IR38MW01A	IR38MW02A	IR38MW03A	
IR-44	IR44MW08A**			
IR-39	IR39MW21A IR39MW22A	IR39MW23A IR39MW24A	IR39MW33A PA39MW01A	PA39MW02A
IR-50	PA50MW05A PA50MW09A	PA50MW06A PA50MW11A	PA50MW07A PA50MW12A	PA50MW08A
IR-55	IR55MW04A			
IR-67	IR67MW04A			
IR-70	IR70MW04A	IR70MW11A		
IR-71	IR71MW03A	IR71MW12B*		

TABLE 4-2 (Continued)

WELLS FOR WATER LEVEL MEASUREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 3 of 3)

IR Site	Monitoring Well			
PARCEL E				
IR-01/21	IR01MW02B IR01MW03A IR01MW07A IR01MW17B IR01MW09B	IR01MW31A IR01MW367A IR01MW43A IR01MW44A	IR01MW47B IR01MW48A IR01MW53B IR01MW58A	IR01MW62A IR01MWI-2 IR01MWI-3 IR01MWI-5
IR-02	IR02MW101A1 IR02MW114A1 IR02MW126A IR02MW127B IR02MW146A	IR02MW175A IR02MW179A IR02MW196A IR02MW206A1 IR02MW210B	IR02MW298A IR02MW299A IR02MW372A IR02MW87A IR02MW89A	IR02MW93A IR02MWB-1 IR02MWB-3 IR02MWB-5
IR-03	IR03MW218A2 IR03MW218A3	IR03MW224A IR03MW228B	IR03MW342A IR03MW371A	
IR-04	IR04MW13A	IR04MW37A	IR04MW40A	
IR-12	IR12MW11A IR12MW13A	IR12MW14A IR12MW15A	IR12MW17A IR12MW20A	
IR-13	IR13MW12A			
IR-11/14/15	IR14MW09A IR15MW06A	IR14MW10A IR15MW07A	IR14MW12A IR15MW08A	IR14MW13A IR11MW25A**
IR-36	IR36MW09A IR36MW11A IR36MW120B IR36MW121A	IR36MW123B IR36MW126A IR36MW128A IR36MW129B	IR36MW135A IR36MW14A IR36MW12A IR36MW17A	PA36MW01A PA36MW02A PA36MW08A IR36MW122A
IR-50	PA50MW10A			
IR-74	IR74MW01A			

Notes: Wells proposed for water-level measurement study

IR Installation restoration

* Well installed during Phase I GDGI and added to water level measurement program for Phase II GDGI

** Existing well added to water level measurement program for Phase II GDGI

TABLE 4-3

WELLS FOR CONFIRMATION LAND SURVEY
FOR PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

(Note: the confirmation land survey and necessary follow-on evaluation* was completed during the Phase I GDGI, and no additional survey work is anticipated for the Phase II GDGI)

IR Site	Monitoring Well	
PARCEL B		
IR-23	UT03MW11A	
IR-26	IR26MW41A	
IR-50	PA50MW01A	
PARCEL C		
IR-25	IR06MW45A	IR25MW11A
IR-28	IR28MW123A IR28MW128A	IR58MW32B
IR-29	IR29MW57A	
IR-58	IR58MW26A	
PARCEL D		
IR-09	IR09MW44A	
IR-22	IR22MW15A	
IR-38	IR38MW02A	
IR-50	PA50MW11A	
IR-70	IR70MW11A	
IR-71	IR71MW03A	
PARCEL E		
IR-01/21	IR01MW48A	IR01MW53B
IR-02	IR02MW114A1	
IR-11	IR11MW25A	
IR-12	IR12MW14A	
IR-36	PA36MW02A	IR36MW11A
IR-50	PA50MW10A	

Note:

* The data collected for the confirmation land survey varied from the historical survey data, and therefore warranted further evaluation during the Phase I GDGI. The Navy resurveyed the top of casing elevations at all wells included in the water-level measurement event for the Phase I GDGI. No further survey work is anticipated for the Phase II GDGI.

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																									Fate and Transport Data														
																										Monitored Natural Attenuation										Laboratory	Laboratory	Field Measurement		
	Laboratory Analyses																									Laboratory Analysis						Field Measurement								
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	CLP PCBs	Pesticides	SVOCs	TPH-ext	TPH-purg	VOCs	Gross Alpha, Gross Beta	Radium-226 and -228	Metals (Calcium, Magnesium, Ferric Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Total Alkalinity	Carbonate, Bicarbonate, Hydroxide alkalinity	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Salinity	Water-Level	Near shore-well--sample at low tide	Comments
Parcel C - IR-25																																								
IR06MW22A																				1	1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		Recently-installed well from Parcel B TPH investigation activities, Pentachlorophenol is only SVOC analyte of concern, VOC analytes of concern include 1,4-DCB
IR06MW32A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		Recently-installed well from Parcel B TPH investigation activities
IR06MW34A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
IR06MW40A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
IR06MW41A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
IR06MW44A						1							1								1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		
IR06MW45A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
IR06MW59A1																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		Recently-installed well from Phase I GDGI
IR06MW59A2																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		Recently-installed well from Phase I GDGI
IR25MW15A1																		1	1		1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		Aroclor-1260/heptachlor epoxide only PCB/pesticide analytes of concern, VOC analytes of concern include 1,2-DCB and 1,4-DCB
IR25MW15A2																		1			1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		Aroclor-1260 only PCB analyte of concern, VOC analytes of concern include 1,2-DCB and 1,4-DCB
IR25MW16A																		1		1	1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		Aroclor-1260 only PCB analyte of concern, hexachloroethane only SVOC analyte of concern
IR25MW17A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		
IR25MW18A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
IR25MW19A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
IR25MW37A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR25MW39A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR25MW40A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		Recently-installed well from Phase I GDGI
IR25MW41A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		Recently-installed well from Phase I GDGI
IR25MW37B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR25MW38B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR25MW39B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR25MW42B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
Total:						**1**							**1**					**3**	**1**	**2**	**23**	**23**	**23**			**23**	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**23**	**8**	**23**		

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																									Fate and Transport Data														
																										Monitored Natural Attenuation														
	Laboratory Analyses																									Laboratory Analysis						Field Measurement				Laboratory	Laboratory	Field Measurement		
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	CLP PCBs	Pesticides	SVOCs	TPH-ext	TPH-purg	VOCs	Gross Alpha, Gross Beta	Radium-226 and -228	Metals (Calcium, Magnesium, Ferric Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Total Alkalinity	Carbonate, Bicarbonate, Hydroxide alkalinity	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Salinity	Water-Level	Near shore-well--sample at low tide	Comments
Parcel C - IR-28																																								
IR28MW122A																					1	1				1	1	1	1	1	1	1	1	1	1	1		1	1	
IR28MW124A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1	1	
IR28MW125A							1	1													1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW126A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW127A								1									1						1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW136A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		
IR28MW150A																					1	1				1	1	1	1	1	1	1	1	1	1	1		1	1	
IR28MW151A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		
IR28MW155A							1	1					1					1			1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		Aroclor-1260 only PCB analyte of concern
IR28MW169A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include 1,4-DCB
IR28MW170A																					1	1				1	1	1	1	1	1	1	1	1	1	1	1	1		
IR28MW171A																		1																		1		1	1	Aroclor-1260 only PCB analyte of concern
IR28MW200A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1	1	
IR28MW217A																							1			1	1	1	1	1	1	1	1	1	1	1	1	1		
IR28MW269A																					1	1				1	1	1	1	1	1	1	1	1	1	1		1	1	
IR28MW270A																							1			1	1	1	1	1	1	1	1	1	1	1		1	1	
IR28MW272A																							1			1	1	1	1	1	1	1	1	1	1	1		1	1	
IR28MW286A																					1	1				1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW287A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW293A																							1			1	1	1	1	1	1	1	1	1	1	1		1	1	
IR28MW298A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW308A																					1	1				1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW311A											1								1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Heptachlor epoxide only pesticide analyte of concern, benzo(a)pyrene only SVOC analyte of concern
IR28MW331A																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW339A																							1			1	1	1	1	1	1	1	1	1	1	1	1	1		
IR28MW394A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	Recently-installed well from Phase I GDGI
IR28MW396A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR28MW397A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR28MW398A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																									Fate and Transport Data														
																									Monitored Natural Attenuation														
	Laboratory Analyses																								Laboratory Analysis						Field Measurement				Laboratory	Laboratory	Field Measurement		
Well No.	**Aluminum**	**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Chromium VI**	**Copper**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Silver**	**Thallium**	**Zinc**	**CLP Metals**	**CLP PCBs**	**Pesticides**	**SVOCs**	**TPH-ext**	**TPH-purg**	**VOCs**	**Gross Alpha, Gross Beta**	**Radium-226 and -228**	**Metals (Calcium, Magnesium, Ferric Iron, Sodium & Potassium)**	**Methane, Ethane, Ethene**	**Nitrate-N, Nitrite-N**	**Sulfate, Chloride**	**Total Alkalinity**	**Carbonate, Bicarbonate, Hydroxide alkalinity**	**Oxygen, dissolved**	**Oxygen Reduction Potential**	**Ferrous Iron (Fe2+)**	**Manganese (II) (Mn2+)**	**Total Dissolved Solids**	**Salinity**	**Water-Level**	**Near shore-well--sample at low tide**	**Comments**
Parcel C - IR-28 (continued)																																							
PA28MW50A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1		1	1	
PA28MW51A																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		
PA50MW03A																							1			1	1	1	1	1	1	1	1	1	1	1		1	1	
IR58MW31A																		1			1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Aroclor-1260 only PCB analyte of concern, VOC analytes of concern include 1,2-DCB and 1,4-DCB
IR28MW173B																							1			1	1	1	1	1	1	1	1	1	1	1	1	1		
IR28MW299B																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW309B																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW314B																							1			1	1	1	1	1	1	1	1	1	1	1	1	1		
IR58MW32B																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR58MW33B																							1			1	1	1	1	1	1	1	1	1	1	1	1	1		VOC analytes of concern include 1,4-DCB
IR28MW394B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR28MW395B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR28MW396B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR28MW397B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR28MW398B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR28MW399B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR28MW400B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR28MW401B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR28MW172F																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW188F																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW189F																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW190F																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW201F																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW211F																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW216F																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW275F																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW300F																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW310F																							1			1	1	1	1	1	1	1	1	1	1	1	1	1		

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																									Fate and Transport Data														
																										Monitored Natural Attenuation														
	Laboratory Analyses																									Laboratory Analysis						Field Measurement				Laboratory	Laboratory	Field Measurement		
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	CLP PCBs	Pesticides	SVOCs	TPH-ext	TPH-purg	VOCs	Gross Alpha, Gross Beta	Radium-226 and -228	Metals (Calcium, Magnesium, Ferric Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Total Alkalinity	Carbonate, Bicarbonate, Hydroxide alkalinity	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Salinity	Water-Level	Near shore-well--sample at low tide	Comments
Parcel C - IR-28 (continued)																																								
IR28MW312F																						1			1	1	1	1	1	1	1	1	1	1	1		1		
IR28MW393F																						1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR28MW402F																						1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
Total:							**2**	**3**			**1**		**1**				**1**	**3**	**1**	**1**	**32**	**32**	**53**			**59**	**59**	**59**	**59**	**59**	**59**	**59**	**59**	**59**	**59**	**60**	**26**	**60**	**12**	
Parcel C - IR-29																																								
IR29MW57A																				1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
PA50MW04A																				1	1				1	1	1	1	1	1	1	1	1	1	1		1		
IR29MW56F																				1	1				1	1	1	1	1	1	1	1	1	1	1		1		
IR29MW72F																				1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
Total:																				**4**	**4**	**2**			**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**		**4**		
Parcel C - IR-58																																								
IR58MW26A																				1	1				1	1	1	1	1	1	1	1	1	1	1		1		
IR58MW25F							1	1																											1		1		
Total:							**1**	**1**												**1**	**1**				**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**		**2**		
Parcel D - IR-09																																								
IR09MW31A							1	1					1																						1	1	1		
IR09MW35A							1	1					1																						1	1	1		
IR09MW51F							1	1					1									1			1	1	1	1	1	1	1	1	1	1	1		1		
IR09PPY1							1	1					1							1	1				1	1	1	1	1	1	1	1	1	1	1		1		
IR09MW54B							1	1					1																						1	1	1		Recently-installed well from Phase I GDGI
IR09MW55B							1	1					1																						1	1	1		Recently-installed well from Phase I GDGI
Total:							**6**	**6**					**6**							**1**	**1**	**1**			**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**6**	**4**	**6**		
Parcel D - IR-22																																								
IR22MW07A			1							1																									1		1	1	
IR22MW08A										1																									1		1	1	
IR22MW15A										1																									1		1	1	
IR22MW16A			1							1																									1		1	1	
Total:			**2**							**4**																									**4**		**4**	**4**	

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																									Fate and Transport Data														
																										Monitored Natural Attenuation														
	Laboratory Analyses																									Laboratory Analysis						Field Measurement				Laboratory	Laboratory	Field Measurement		
Well No.	**Aluminum**	**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Chromium VI**	**Copper**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Silver**	**Thallium**	**Zinc**	**CLP Metals**	**CLP PCBs**	**Pesticides**	**SVOCs**	**TPH-ext**	**TPH-purg**	**VOCs**	**Gross Alpha, Gross Beta**	**Radium-226 and -228**	**Metals (Calcium, Magnesium, Ferric Iron, Sodium & Potassium)**	**Methane, Ethane, Ethene**	**Nitrate-N, Nitrite-N**	**Sulfate, Chloride**	**Total Alkalinity**	**Carbonate, Bicarbonate, Hydroxide alkalinity**	**Oxygen, dissolved**	**Oxygen Reduction Potential**	**Ferrous Iron (Fe2+)**	**Manganese (II) (Mn2+)**	**Total Dissolved Solids**	**Salinity**	**Water-Level**	**Near shore-well--sample at low tide**	**Comments**
Parcel D - IR-33 North																																								
IR33MW61A			1				1	1					1								1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		Benzene only analyte of concern for VOCs
IR33MW62A																					1	1				1	1	1	1	1	1	1	1	1	1	1		1		
IR33MW64A																					1	1				1	1	1	1	1	1	1	1	1	1	1		1		
IR33MW65A																					1	1				1	1	1	1	1	1	1	1	1	1	1		1		
IR33MW66A																					1	1				1	1	1	1	1	1	1	1	1	1	1		1		
PA50MW11A																					1	1				1	1	1	1	1	1	1	1	1	1	1		1		
Total:			**1**				**1**	**1**					**1**								**6**	**6**	**1**			**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**		**6**		
Parcel D - IR-33 South																																								
IR09MW44A							1	1					1																							1		1		
IR09P043A							1	1					1																							1		1		
PA33MW37A							1	1		1			1																							1	1	1		
IR33MW120B							1	1					1																							1	1	1		Recently-installed well from Phase I GDGI
IR33MW121B							1	1					1																							1		1		Recently-installed well from Phase I GDGI
Total:							**5**	**5**		**1**			**5**																							**5**	**2**	**5**		
Parcel D - IR-34																																								
IR34MW01A							1	1					1								1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		Benzene only analyte of concern for VOCs
IR34MW36A							1	1					1								1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR34MW37A							1	1					1								1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR34MW36B							1	1					1								1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
IR34MW37B							1	1					1								1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
Total:							**5**	**5**					**5**								**5**	**5**	**5**			**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**4**	**5**		
Parcel D - IR-37																																								
IR37MW26B							1	1					1																							1		1		Recently-installed well from Phase I GDGI
Total:							**1**	**1**					**1**																							**1**		**1**		
Parcel D - IR-38																																								
IR38MW03A																					1	1				1	1	1	1	1	1	1	1	1	1	1		1		
Total:																					**1**	**1**				**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		**1**		

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Well No.	Analytes of Concern Data																									Fate and Transport Data														Comments
	Laboratory Analyses																									Monitored Natural Attenuation										Laboratory	Laboratory	Field Measurement		
																										Laboratory Analysis						Field Measurement								
	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	CLP PCBs	Pesticides	SVOCs	TPH-ext	TPH-purg	VOCs	Gross Alpha, Gross Beta	Radium-226 and -228	Metals (Calcium, Magnesium, Ferric Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Total Alkalinity	Carbonate, Bicarbonate, Hydroxide alkalinity	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Salinity	Water-Level	Near shore-well--sample at low tide	
Parcel D - IR-71																																								
IR71MW03A																							1			1	1	1	1	1	1	1	1	1	1	1	1	1		
IR71MW12B																							1			1	1	1	1	1	1	1	1	1	1	1	1	1		Recently-installed well from Phase I GDGI
Total:																							**2**			**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**		
Parcel E - IR01																																								
IR01MW03A	1								1	1			1			1		1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		SVOC analytes of concern include 1,4-DCB; VOC analytes include benzene
IR01MW05A	1	1	1			1	1	1	1	1		1	1	1		1		1					1	1		1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include benzene
IR01MW07A													1								1	1		1		1	1	1	1	1	1	1	1	1	1	1		1		
IR01MW16A	1								1	1		1	1					1			1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1		VOC analytes of concern include benzene
IR01MW18A	1						1	1	1	1		1	1			1		1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		SVOC analytes of concern include phenanthrene; VOC analytes include benzene
IR01MW31A	1									1								1					1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include benzene and HVOCs
IR01MW38A																							1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	VOC analytes of concern include benzene
IR01MW42A										1													1	1		1	1	1	1	1	1	1	1	1	1	1		1		
IR01MW43A		1																1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	SVOC analytes of concern include 1,4-DCB; VOC analytes include benzene and HVOCs
IR01MW48A	1			1			1	1	1	1						1							1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	VOC analytes of concern include benzene
IR01MW58A				1																	1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include benzene
IR01MW62A	1	1	1	1		1	1	1	1	1		1	1			1				1																1		1	1	SVOCs analytes of concern include PAHs
IR01MW63A				1																																1		1	1	
IR01MW366A						1			1			1	1			1				1	1	1		1		1	1	1	1	1	1	1	1	1	1	1		1		
IR01MW367A																1			1		1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include benzene
IR01MW400A[b]																		1																		1		1		
IR01MW401A																	1			1			1			1	1	1	1	1	1	1	1	1	1	1		1		
IR01MW402A[a]																					1	1				1	1	1	1	1	1	1	1	1	1	1		1		
IR01MW403A																	1			1			1			1	1	1	1	1	1	1	1	1	1	1		1		
IR01MWI-2	1		1	1	1		1	1	1	1		1	1			1								1												1		1		

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																									Fate and Transport Data														
	Laboratory Analyses																									Monitored Natural Attenuation														
																										Laboratory Analysis						Field Measurement				Laboratory	Laboratory	Field Measurement		
Well No.	**Aluminum**	**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Chromium VI**	**Copper**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Silver**	**Thallium**	**Zinc**	**CLP Metals**	**CLP PCBs**	**Pesticides**	**SVOCs**	**TPH-ext**	**TPH-purg**	**VOCs**	**Gross Alpha, Gross Beta**	**Radium-226 and -228**	**Metals (Calcium, Magnesium, Ferric Iron, Sodium & Potassium)**	**Methane, Ethane, Ethene**	**Nitrate-N, Nitrite-N**	**Sulfate, Chloride**	**Total Alkalinity**	**Carbonate, Bicarbonate, Hydroxide alkalinity**	**Oxygen, dissolved**	**Oxygen Reduction Potential**	**Ferrous Iron (Fe2+)**	**Manganese (II) (Mn2+)**	**Total Dissolved Solids**	**Salinity**	**Water-Level**	**Near shore-well--sample at low tide**	**Comments**
Parcel E - IR01 (continued)																																								
IR01MWI-3													1			1		1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	SVOC analytes of concern include PAHs; VOC analytes include benzene
IR01MWI-5		1		1			1	1	1	1		1	1			1		1	1	1			1	1		1	1	1	1	1	1	1	1	1	1	1	1	1		
IR01MWI-7[b]																	1			1			1			1	1	1	1	1	1	1	1	1	1	1		1	1	VOC analytes of concern include benzene
IR01MWI-8[c]																	1			1			1			1	1	1	1	1	1	1	1	1	1	1		1	1	
IR01MWI-9	1	1	1	1		1	1	1	1	1		1	1	1		1		1	1	1																1		1	1	SVOCs analytes of concern include PAHs
IR01MW02B	1						1	1												1			1	1		1	1	1	1	1	1	1	1	1	1	1	1	1		SVOC analytes of concern include phenanthrene
IR01MW09B																					1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		VOC analytes of concern include benzene
IR01MW17B	1	1				1												1		1			1	1		1	1	1	1	1	1	1	1	1	1	1	1	1		SVOC analytes of concern include bis(2-ethylhxyl)phthalate; VOC analytes include benzene
IR01MW26B[a]																				1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1		VOC analytes of concern include benzene
IR01MW47B																				1			1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	VOC analytes of concern include HVOCs
IR01MW53B						1															1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	VOC analytes of concern include benzene
Total:	**11**	**6**	**4**	**7**	**1**	**6**	**8**	**8**	**10**	**11**		**8**	**11**	**2**		**11**	**4**	**11**	**5**	**16**	**12**	**12**	**23**	**18**	**2**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**26**	**31**	**11**	**31**	**11**	
Parcel E - IR02																																								
IR01MW44A																1		1	1		1	1		1		1	1	1	1	1	1	1	1	1	1	1		1	1	
IR02MW89-A	1												1											1												1		1		
IR02MW93-A													1											1												1		1		
IR02MW101A1	1						1	1					1							1																1		1		SVOC analytes of concern include pentachlorophenol
IR02MW101A2				1		1																		1												1		1		
IR02MW114A1						1																														1		1		
IR02MW114A2	1					1	1	1	1				1											1												1		1		
IR02MW114A3				1		1																														1		1		
IR02MW126A				1					1	1						1		1						1	1											1		1	1	
IR02MW141A	1	1		1		1	1	1	1	1		1	1	1		1		1	1	1				1	1											1		1	1	

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	CLP PCBs	Pesticides	SVOCs	TPH-ext	TPH-purg	VOCs	Gross Alpha, Gross Beta	Radium-226 and -228	Metals (Calcium, Magnesium, Ferric Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Total Alkalinity	Carbonate, Bicarbonate, Hydroxide alkalinity	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Salinity	Water-Level	Near shore-well--sample at low tide	Comments
	Analytes of Concern Data																									Fate and Transport Data														
	Laboratory Analyses																									Monitored Natural Attenuation: Laboratory Analysis						Monitored Natural Attenuation: Field Measurement				Laboratory	Laboratory	Field Measurement		
Parcel E - IR02 (continued)																																								
IR02MW147A																				1				1												1		1	1	SVOC analytes of concern include pentachlorophenol
IR02MW149A									1															1												1		1	1	
IR02MW175A	1																		1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	VOC analytes of concern include HVOCs
IR02MW179A						1							1							1			1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		SVOC analytes of concern include pentachlorophenol
IR02MW206A1																							1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	
IR02MW206A2																							1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	
IR02MW209A																								1	1											1		1	1	
IR02MW298A						1	1	1	1				1											1												1		1		
IR02MW300A									1				1			1				1			1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	
IR02MW372A																			1				1	1		1	1	1	1	1	1	1	1	1	1	1	1	1		VOC analytes of concern include benzene and HVOCs
IR02MW373A		1				1			1	1			1			1		1						1												1		1	1	
IR02MWB-1	1		1				1	1	1				1			1								1	1											1		1	1	
IR02MWB-2	1						1	1	1	1		1	1		1	1							1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	
IR02MWB-3	1	1				1	1	1	1	1		1	1			1			1	1				1	1											1		1	1	SVOC analytes of concern include PAHs and pentachlorphenol
IR02MW127B																			1				1	1		1	1	1	1	1	1	1	1	1	1	1	1	1		
Total:	**8**	**3**	**1**	**4**		**9**	**7**	**7**	**10**	**5**		**3**	**12**	**1**	**1**	**8**		**4**	**6**	**7**	**1**	**1**	**8**	**22**	**10**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**25**	**2**	**25**	**14**	
Parcel E - IR03																																								
IR02MW97A			1	1		1	1	1					1					1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1		SVOC analytes of concern include pentachlorophenol
IR02MW146A			1	1									1					1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	SVOC analytes of concern include pentachlorophenol; VOC analyte includes benzene
IR02MW173A[d]			1	1																1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	SVOC analytes of concern include pentachlorophenol; VOC analyte includes benzene
IR02MW299A									1														1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	VOC analytes of concern include HVOCs
IR02MWB-5													1					1						1	1											1		1	1	
IR03MW218A1[d]				1					1	1								1		1				1	1											1	1		1	SVOC analytes of concern include phananthrene
IR03MW218A2				1					1	1						1					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	VOC analytes of concern include benzene

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																									Fate and Transport Data														
																										Monitored Natural Attenuation														
	Laboratory Analyses																									Laboratory Analysis						Field Measurement				Laboratory	Laboratory	Field Measurement		
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	CLP PCBs	Pesticides	SVOCs	TPH-ext	TPH-purg	VOCs	Gross Alpha, Gross Beta	Radium-226 and -228	Metals (Calcium, Magnesium, Ferric Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Total Alkalinity	Carbonate, Bicarbonate, Hydroxide alkalinity	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Salinity	Water-Level	Near shore-well--sample at low tide	Comments
Parcel E - IR03 (continued)																																								
IR03MW218A3				1																			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	VOC analytes of concern include benzene
IR03MW224A	1		1	1			1	1	1				1					1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1		
IR03MW225A[d]													1					1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1			1	VOC analytes of concern include HVOCs
IR03MW226A[d]	1	1		1			1	1	1	1		1	1			1		1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1			1	SVOC analytes of concern include phenanthrene, VOC analytes include HVOCs and benzene
IR03MW342A	1		1	1			1	1	1	1		1	1			1		1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	SVOC analytes of concern include pentachlorophenol; VOC analytes include benzene
IR03MW369A[d]			1	1									1					1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1			1	SVOC analytes of concern include phenanthrene and pentachlorophenol, VOC analytes include benzene
IR03MW370A[d]			1	1									1					1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1			1	SVOC analytes of concern include phenanthrene, VOC analytes include benzene
IR03MW371A			1	1									1					1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1			1	VOC analytes of concern include pentachlorophenol
IR03MWO-1[d]	1		1	1			1	1	1	1		1	1			1		1		1			1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	VOC analytes of concern include benzene and HVOCs
IR02MW210B																							1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	VOC analytes of concern include HVOCs
IR03MW228B				1		1													1	1			1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Total:	**4**	**1**	**9**	**14**		**2**	**5**	**5**	**7**	**5**		**3**	**11**			**4**		**12**	**2**	**13**	**11**	**11**	**16**	**18**	**5**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**18**	**4**	**12**	**16**	
Parcel E - IR04																																								
IR04MW13A																							1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR04MW31A			1																				1			1	1	1	1	1	1	1	1	1	1	1		1		
IR04MW35A													1										1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR04MW36A			1																																	1	1	1		
IR04MW37A																							1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR04MW38A																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR04MW39A																							1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR04MW40A						1				1			1																							1		1		
PA50MW10A						1			1	1						1							1			1	1	1	1	1	1	1	1	1	1	1		1		
Total:			**2**			**2**			**1**	**2**			**2**			**1**							**7**			**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**9**	**1**	**9**		

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data: Laboratory Analyses																									Fate and Transport Data: Monitored Natural Attenuation: Laboratory Analysis						Field Measurement				Laboratory	Laboratory	Field Measurement		
Well No.	**Aluminum**	**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Chromium VI**	**Copper**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Silver**	**Thallium**	**Zinc**	**CLP Metals**	**CLP PCBs**	**Pesticides**	**SVOCs**	**TPH-ext**	**TPH-purg**	**VOCs**	**Gross Alpha, Gross Beta**	**Radium-226 and -228**	**Metals (Calcium, Magnesium, Ferric Iron, Sodium & Potassium)**	**Methane, Ethane, Ethene**	**Nitrate-N, Nitrite-N**	**Sulfate, Chloride**	**Total Alkalinity**	**Carbonate, Bicarbonate, Hydroxide alkalinity**	**Oxygen, dissolved**	**Oxygen Reduction Potential**	**Ferrous Iron (Fe2+)**	**Manganese (II) (Mn2+)**	**Total Dissolved Solids**	**Salinity**	**Water-Level**	**Near shore-well--sample at low tide**	**Comments**
Parcel E - IR05																																								
IR05MW73A																		1																		1		1		
IR05MW77A										1																										1		1		
IR05MW85A			1			1			1			1								1																1		1		SVOC analytes of concern include phenanthrene
Total:			**1**			**1**			**1**	**1**		**1**						**1**		**1**																**3**		**3**		
Parcel E - IR11																																								
IR11MW25A																			1				1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR11MW26A																							1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR11MW27A									1														1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
Total:									**1**										**1**				**3**			**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**		**3**		
Parcel E - IR12																																								
IR12MW11A																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR12MW13A																							1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR12MW14A																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR12MW17A				1															1		1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs and benzene
IR12MW18A			1										1										1			1	1	1	1	1	1	1	1	1	1	1		1		
IR12MW19A																							1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR12MW20A			1																				1	1		1	1	1	1	1	1	1	1	1	1	1		1		
IR12MW21A[d]			1	1		1													1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		SVOC analytes of concern include phenanthrene; VOC analytes include HVOCs
Total:			**3**	**2**		**1**							**1**						**2**	**1**	**2**	**2**	**8**	**1**		**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**8**		**8**		
Parcel E - IR14																																								
IR14MW09A												1	1						1		1	1		1		1	1	1	1	1	1	1	1	1	1	1		1		
IR14MW10A		1	1	1		1				1			1					1		1			1	1		1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include pentachlorophenol
IR14MW12A						1							1						1		1	1		1		1	1	1	1	1	1	1	1	1	1	1		1		
IR14MW13A				1																1	1	1		1		1	1	1	1	1	1	1	1	1	1	1		1		SVOC analytes of concern include phenanthrene
IR15MW06A										1					1						1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR15MW07A										1				1							1	1		1		1	1	1	1	1	1	1	1	1	1	1		1		
IR15MW08A																				1	1	1		1		1	1	1	1	1	1	1	1	1	1	1		1		SVOC analytes of concern include phenanthrene
Total:		**1**	**1**	**2**		**2**				**3**		**1**	**3**	**1**	**1**			**1**	**2**	**3**	**6**	**6**	**2**	**6**		**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**		**7**		

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																									Fate and Transport Data														
																										Monitored Natural Attenuation										Laboratory	Laboratory	Field Measurement		
	Laboratory Analyses																									Laboratory Analysis						Field Measurement								
Well No.	**Aluminum**	**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Chromium VI**	**Copper**	**Lead**	**Manganese**	**Mercury**	**Nickel**	**Silver**	**Thallium**	**Zinc**	**CLP Metals**	**CLP PCBs**	**Pesticides**	**SVOCs**	**TPH-ext**	**TPH-purg**	**VOCs**	**Gross Alpha, Gross Beta**	**Radium-226 and -228**	**Metals (Calcium, Magnesium, Ferric Iron, Sodium & Potassium)**	**Methane, Ethane, Ethene**	**Nitrate-N, Nitrite-N**	**Sulfate, Chloride**	**Total Alkalinity**	**Carbonate, Bicarbonate, Hydroxide alkalinity**	**Oxygen, dissolved**	**Oxygen Reduction Potential**	**Ferrous Iron (Fe2+)**	**Manganese (II) (Mn2+)**	**Total Dissolved Solids**	**Salinity**	**Water-Level**	**Near shore-well--sample at low tide**	**Comments**
Parcel E - IR15																																								
IR15MW09F																							1	1		1	1	1	1	1	1	1	1	1	1	1		1		
IR15MW10F			1																				1			1	1	1	1	1	1	1	1	1	1	1		1		
Total:			**1**																				**2**	**1**		**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**		**2**		
Parcel E - IR36																																								
IR36MW11A																			1		1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1		
IR36MW12A																					1	1		1		1	1	1	1	1	1	1	1	1	1	1		1		
IR36MW14A																							1			1	1	1	1	1	1	1	1	1	1	1		1		
IR36MW125A																							1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR36MW126A																							1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR36MW127A																							1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR36MW128A																			1				1			1	1	1	1	1	1	1	1	1	1	1	1	1		
IR36MW135A						1																														1				
PA36MW03A[d]									1							1			1																	1		1		Pesticide analytes of concern include 4,4' DDT
PA36MW04A									1										1				1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
PA36MW07A																			1				1			1	1	1	1	1	1	1	1	1	1	1		1		Pesticides analytes of concern include heptachlor; VOC analytes include HVOCs
PA36MW08A																				1	1	1				1	1	1	1	1	1	1	1	1	1	1		1		
IR39MW21A		1																1	1	1			1			1	1	1	1	1	1	1	1	1	1	1		1		Pesticides analytes of concern include heptachlor; VOC analytes include benzene
IR39MW23A	1																																			1		1		
IR39MW33A				1																			1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include benzene
IR36MW120B																							1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
Parcel E - IR36 (continued)																																								
IR36MW123B																							1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include HVOCs
IR36MW129B																							1			1	1	1	1	1	1	1	1	1	1	1	1	1		
Total:	**1**	**1**		**1**		**1**			**2**							**1**		**1**	**6**	**2**	**3**	**3**	**13**	**2**		**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**18**	**2**	**17**		

TABLE 4-4

DATA COLLECTION REQUIREMENTS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

	Analytes of Concern Data																								Fate and Transport Data														
	Laboratory Analyses																								Monitored Natural Attenuation: Laboratory Analysis						Monitored Natural Attenuation: Field Measurement				Laboratory	Laboratory	Field Measurement		
Well No.	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Chromium VI	Copper	Lead	Manganese	Mercury	Nickel	Silver	Thallium	Zinc	CLP Metals	CLP PCBs	Pesticides	SVOCs	TPH-ext	TPH-purg	VOCs	Gross Alpha, Gross Beta	Radium-226 and -228	Metals (Calcium, Magnesium, Ferric Iron, Sodium & Potassium)	Methane, Ethane, Ethene	Nitrate-N, Nitrite-N	Sulfate, Chloride	Total Alkalinity	Carbonate, Bicarbonate, Hydroxide alkalinity	Oxygen, dissolved	Oxygen Reduction Potential	Ferrous Iron (Fe2+)	Manganese (II) (Mn2+)	Total Dissolved Solids	Salinity	Water-Level	Near shore-well--sample at low tide	Comments
Parcel E - IR56																																							
IR56MW39A																				1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		VOC analytes of concern include benzene
Total:																				**1**	**1**	**1**			**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		**1**		
Parcel E - IR72																																							
IR72MW32A																		1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1		1		
Total:																		**1**	**1**	**1**	**1**	**1**			**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		**1**		
Parcel E - IR73																																							
IR73MW04A																				1	1				1	1	1	1	1	1	1	1	1	1	1		1		
Total:																				**1**	**1**				**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		**1**		
Grand Total:	**24**	**12**	**25**	**30**	**1**	**25**	**41**	**42**	**32**	**32**	**1**	**16**	**60**	**4**	**2**	**25**	**5**	**36**	**27**	**47**	**111**	**111**	**171**	**68**	**17**	**199**	**199**	**199**	**199**	**199**	**199**	**199**	**199**	**199**	**199**	**246**	**66**	**239**	**57**	

Notes:

a	These wells have not been located, and may not be available for sampling. Additional wells will be sampled if appropriate and/or new wells will be installed as necessary.
b	The lids of these wells could not be opened during the well condition survey, and may not be available for sampling. Additional wells will be sampled if appropriate and/or new wells will be installed as necessary.
c	This well was silted more than 50 percent, and may not be possible to sample. Redevelopment will be attempted. If not successful, a new well will be installed.
d	These wells have viscous free product, and may not be possible to sample.

CLP	Contract laboratory program	PAH	Polyaromatic hydrocarbons	TDS	Total dissolved solids
HVOC	Halogen volatile organic compounds	PCB	Polychlorinated biphenyls	TPH-ext	Total petroleum hydrocarbons-extractable range
IR	Installation restoration	SVOC	Semivolatile organic compounds	TPH-purg	Total petroleum hydrocarbons-purgeable range
				VOC	Volatile organic compound

Refer to Tables 4-5, 4-6, and 4-7 of FSP addendum for specific rationale for sampling at each well

Refer to Table 2-1 (Appendix 2 of accompanying QAPP addendum) for specific groundwater analytical protocol (analytical method, sample volumes & containers, preservation, holding time, etc.)

In accordance with standard groundwater sampling procedures, groundwater temperature, pH, and conductivity measurements will be made with field equipment to ensure that samples are collected from representative formation water.

The wells indicated for MNA analysis will be sampled as feasible, but the total number of wells to be sampled may be reduced based on field conditions.

Turbidity will also be measured with field equipment to monitor for particulate interference.

QA/QC Samples:	**Equipment Rinsate**: One per day per parameter.	**Trip Blank:** One per cooler containing samples for VOC analysis.	**Matrix Spike/Matrix Spike Duplicate:** One for every 20 wells sampled or portion thereof. Requires double volume of water to be collected.
	Field Duplicate: One for every 10 wells or portion thereof.	**Source Water Blank**: One per source per event, as nec.	

TABLE 4-5

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-25 (A-aquifer)	IR06MW22A	• VOCs (incl. 1,4-DCB) • TPH-extractables • TPH-purgeables • Pentachlorophenol • MNA • TDS	• Evaluate shallow VOCs and TPH in vicinity of excavation A-1 at Parcel B • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR06MW32A	• VOCs (incl. 1,4-DCB) • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR06MW34A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR06MW40A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR06MW41A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR06MW44A	• VOCs • Cadmium • Nickel • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs, metals, and TPH • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 14)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-25 (A-aquifer) (cont'd)	IR06MW45A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR06MW59A1 (new well—added during Phase I GDGI field work)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate shallow VOCs and TPH in vicinity of excavation A-1 at Parcel B • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR06MW59A2 (new well—added during Phase I GDGI field work)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate deep VOCs and TPH in vicinity of excavation A-1 at Parcel B • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW15A1	• VOCs (incl. 1,2-DCB and 1,4-DCB) • Aroclor-1260 • Heptachlor epoxide • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow contaminants • Concentrations of VOCs and SVOCs exceeded MCLs in multiple rounds • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW15A2	• VOCs (including 1,2-DCB and 1,4-DCB) • Aroclor-1260 • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, deeper contaminants • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 3 of 14)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-25 (A-aquifer) (cont'd)	IR25MW16A	• VOCs • Aroclor-1260 • Hexachloroethane • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow contaminants • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW17A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW18A	• VOCs • TPH-extractables • TPH-purgeables • MNA	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW19A	• VOCs • TPH-extractables • TPH-purgeables • MNA	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW37A (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW39A (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 4 of 14)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-25 (A-aquifer) (cont'd)	IR25MW40A (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, deeper VOCs and TPH (to be screened at bottom of A-aquifer) • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW41A (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C5, deeper VOCs and TPH (to be screened at bottom of A-aquifer) • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-25 (B-aquifer)	IR25MW37B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C5 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW38B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C5 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW39B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C5 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR25MW42B (new well—added during Phase I GDGI field work)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer and vicinity of RU-C5 • Determine whether chemicals from RU-C5 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 5 of 14)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer)	IR28MW122A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW124A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW125A	• VOCs • Chromium, Cr VI • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW126A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW127A	• Metals • VOCs • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW136A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW150A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
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IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont'd)	IR28MW151A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW155A	• VOCs • TPH-extractables • Aroclor-1260 • Chromium, Cr VI • Nickel • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Confirm extent of ecological RU-7 (well IR28MW129A not available for sampling) • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW169A	• VOCs (incl 1,4-DCB) • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW170A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW171A	• Aroclor-1260 • TDS	• Confirm extent of ecological RU-3 • Obtain TDS data for beneficial use analysis
	IR28MW200A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW217A	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
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IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont'd)	IR28MW269A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW270A	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW272A	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW286A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C2 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW287A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C2 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW293A	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW298A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C4 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW308A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
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IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont'd)	IR28MW311A	• VOCs • Benzo(a)pyrene • Heptachlor epoxide • Manganese • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW331A	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW339A	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW394A (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C4, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW396A (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C2, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW397A (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C2, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW398A (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C2, shallow VOCs and TPH • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
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IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (A-aquifer) (cont'd)	PA28MW50A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	PA28MW51A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C1 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	PA50MW03A	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR58MW31A	• VOCs (incl 1,2-DCB and 1,4-DCB) • Aroclor-1260 • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C2 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-28 (B-aquifer)	IR28MW173B	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW299B	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW309B	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW314B	• VOCs • MNA • TDS	• Confirm extent of RU-C1 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
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IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (B-aquifer) (cont'd)	IR58MW32B	• VOCs • MNA • TDS	• Confirm extent of RU-C2 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings
	IR58MW33B	• VOCs (including 1,4-DCB) • MNA • TDS	• Confirm extent of RU-C2 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW394B (New well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C4 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW395B (New well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C7 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW396B (New well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C2 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW397B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C2 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
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IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (B-aquifer) (cont'd)	IR28MW398B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C2 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW399B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C1 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW400B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C1 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW401B (new well)	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-C1 have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-28 (bedrock wells)	IR28MW172F	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW188F	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Most recent sampling event in 1995 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
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IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (bedrock wells) (cont'd)	IR28MW189F	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Most recent sampling event in 1995 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW190F	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW201F	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW211F	• VOCs • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Only one round of sampling was conducted for cis-1,2-dichloroethene and 1,1,2-trichloroethane • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW216F	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW275F	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW300F	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW310F	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
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IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-28 (bedrock wells) (cont'd)	IR28MW312F	• VOCs • MNA • TDS	• Confirm extent of RU-C7 • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW393F (New well—converted from B-aquifer well to bedrock well during Phase I GDGI field work)	• VOCs • MNA • TDS	• Confirm extent of RU-C4 within deeper, competent, bedrock formation • Well installed in bedrock zone since no significant B-aquifer sediments were present at location • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR28MW402F (New well—added during Phase I GDGI field work)	• VOCs • MNA • TDS	• Confirm extent of RU-C4 within shallower, more weathered, bedrock formation • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-29 (A-aquifer)	IR29MW57A	• VOCs • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	PA50MW04A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-29 (bedrock wells)	IR29MW56F	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR29MW72F	• Benzene • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm benzene concentrations • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-5 (Continued)

PARCEL C WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 14 of 14)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-58 (A-aquifer)	IR58MW26A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-58 (bedrock wells)	IR58MW25F	• Chromium, Cr VI • MNA • TDS	• Confirm extent of RU-C4 and RU-C7 • Confirm chromium contamination • Conclusions from 3/7/00, 3/16/00, and 3/23/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

Notes: MNA parameters include: reduced metals ferrous iron (Fe2+), ferric iron (Fe3+), and manganese (II), nitrate, nitrite, sulfate, dissolved oxygen, chloride, total alkalinity, hydroxide alkalinity, carbonate, bicarbonate, calcium, magnesium, sodium, potassium, and total dissolved solids (TDS). The wells indicated for MNA analysis will be sampled as feasible, but the total number of wells to be sampled may be reduced based on field conditions.

BCT Base Realignment and Closure (BRAC) Cleanup Team
CAP Corrective action plan
DCB Dichlorobenzene
HGAL Hunters Point groundwater ambient level
MCL Maximum contaminant level
MNA Monitored natural attenuation
RU Remedial unit
SVOC Semivolatile organic compounds
TDS Total dissolved solids
TPH Total petroleum hydrocarbons
VOC Volatile organic compounds

TABLE 4-6

PARCEL D WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-09 (A-aquifer)	IR09MW31A	• Chromium, Cr VI • Nickel • TDS	• Confirm chromium and nickel concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Well located and sampled during Phase I GDGI; eliminated need to install new well IR09MW54A • Obtain TDS data for beneficial use analysis
	IR09MW35A	• Chromium, Cr VI • Nickel • TDS	• Confirm chromium and nickel concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Obtain TDS data for beneficial use analysis
	IR09MW51F	• Chromium, Cr VI • Nickel • Trichloroethene • Methylene chloride • TDS	• Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Obtain TDS data for beneficial use analysis
	IR09PPY1	• Chromium, Cr VI • Nickel • TPH-extractables • TPH-purgeables • MNA • TDS	• Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-09 (B-aquifer)	IR09MW54B (new well)	• Chromium, Cr VI • Nickel • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-D1 have migrated to the B-aquifer • Obtain TDS data for beneficial use analysis
	IR09MW55B (new well)	• Chromium, Cr VI • Nickel • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine if chemicals from RU-D1 have migrated to the B-aquifer • Obtain TDS data for beneficial use analysis
IR-22 (A-aquifer)	IR22MW07A	• Arsenic • Lead • TDS	• Confirm arsenic and lead concentrations • Recommendation from 12/5/00 BCT working meeting and 12/12/00 BCT monthly meeting • Obtain TDS data for beneficial use analysis (previous TDS concentrations exceeded 10,000 milligrams per liter)

TABLE 4-6 (Continued)

PARCEL D WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 5)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-22 (A-aquifer) (cont'd)	IR22MW08A	• Lead • TDS	• Confirm lead concentrations • Recommendation from 12/5/00 BCT working meeting and 12/12/00 BCT monthly meeting • Obtain TDS data for beneficial use analysis (previous TDS concentrations exceeded 10,000 milligrams per liter)
	IR22MW15A	• Lead • TDS	• Confirm lead concentrations • Recommendation from 12/5/00 BCT working meeting and 12/12/00 BCT monthly meeting • Obtain TDS data for beneficial use analysis (previous TDS concentrations exceeded 10,000 milligrams per liter)
	IR22MW16A	• Arsenic • Lead • TDS	• Confirm arsenic and lead concentrations • Recommendation from 12/5/00 BCT working meeting and 12/12/00 BCT monthly meeting • Obtain TDS data for beneficial use analysis (previous TDS concentrations exceeded 10,000 milligrams per liter)
IR-33 North (A-aquifer)	IR33MW61A	• Benzene • Chromium, Cr VI • Nickel • Arsenic • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm chromium, nickel, and benzene concentrations • Evaluate potential relationship of nickel concentrations to surrounding chromium concentrations • Isolated detection of arsenic, followed by two rounds below MCLs • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR33MW62A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR33MW64A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-6 (Continued)

PARCEL D WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 3 of 5)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-33 North (A-aquifer) (cont'd)	IR33MW65A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR33MW66A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	PA50MW11A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-33 South (A-aquifer)	IR09MW44A	• Chromium, Cr VI • Nickel • TDS	• Evaluate potential relationship of nickel concentrations to surrounding chromium concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Obtain TDS data for beneficial use analysis
	IR09P043A	• Chromium, Cr VI • Nickel • TDS	• Confirm chromium and nickel concentrations • Evaluate potential relationship of nickel concentrations to surrounding chromium concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Obtain TDS data for beneficial use analysis
	PA33MW37A	• Chromium, Cr VI • Nickel • Lead • TDS	• Isolated nickel and lead concentrations above MCLs, followed by one round with results below the MCL • Evaluate potential relationship of nickel concentrations to surrounding chromium concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Obtain TDS data for beneficial use analysis
IR-33 South (B-aquifer)	IR33MW120B (new well)	• Chromium, Cr VI • Nickel • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-D1 have migrated to the B-aquifer • Obtain TDS data for beneficial use analysis

TABLE 4-6 (Continued)

PARCEL D WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 4 of 5)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-33 South (B-aquifer) (cont'd)	IR33MW121B (new well)	• Chromium, Cr VI • Nickel • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-D1 have migrated to the B-aquifer • Obtain TDS data for beneficial use analysis
IR-34 (A-aquifer)	IR34MW01A	• Chromium, Cr VI • Nickel • Benzene • TPH-extractables • TPH-purgeables • MNA • TDS	• Confirm chromium, nickel, and benzene concentrations • Evaluate potential relationship of nickel concentrations to surrounding chromium concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR34MW36A (new well)	• Chromium, Cr VI • Nickel • Benzene • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from upgradient areas have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
	IR34MW37A (new well)	• Chromium, Cr VI • Nickel • Benzene • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from upgradient areas have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-34 (B-aquifer)	IR34MW36B (new well)	• Chromium, Cr VI • Nickel • Benzene • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from upgradient areas have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

TABLE 4-6 (Continued)

PARCEL D WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 5 of 5)

IR Site	Monitoring Well	Target Analysis	Rationale for Resampling
IR-34 (B-aquifer) (cont'd)	IR34MW37B (new well)	• Chromium, Cr VI • Nickel • Benzene • TPH-extractables • TPH-purgeables • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from upgradient areas have migrated to the B-aquifer • Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-37 (A-aquifer)	IR37MW26B (new well)	• Chromium, Cr VI • Nickel • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from RU-D1 have migrated to the B-aquifer • Obtain TDS data for beneficial use analysis
IR-38 (A-aquifer)	IR38MW03A	• TPH-extractables • TPH-purgeables • MNA • TDS	• Provide additional data for petroleum CAP • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-71 (A-aquifer)	IR71MW03A	• VOCs • MNA • TDS	• Confirm trichloroethene, tetrachloroethene, and carbon tetrachloride concentrations • Conclusions from 2/7/00 and 3/16/00 BCT working meetings • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis
IR-71 (B-aquifer)	IR71MW12B (new well)	• VOCs • MNA • TDS	• Evaluate geology and hydrogeology of B-aquifer • Determine whether chemicals from the A-aquifer have migrated to the B-aquifer • Assess progress of natural attenuation • Obtain TDS data for beneficial use analysis

Notes: MNA parameters include: reduced metals ferrous iron (Fe2+), ferric iron (Fe3+), and manganese (II), nitrate, nitrite, sulfate, dissolved oxygen, chloride, total alkalinity, hydroxide alkalinity, carbonate, bicarbonate, calcium, magnesium, sodium, potassium, and total dissolved solids (TDS). The wells indicated for MNA analysis will be sampled as feasible, but the total number of wells to be sampled may be reduced based on field conditions.

BCT Base Realignment and Cleanup (BRAC) Closure Team
CAP Corrective action plan
Cr VI Hexavalent chromium
MCL Maximum contaminant level
MNA Monitored natural attenuation
RU Remedial unit
TDS Total dissolved solids
TPH Total petroleum hydrocarbons
VOC Volatile organic compound

TABLE 4-7

PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-01	IR01MW03A	Aluminum	MCL	Confirm extent of listed metals
(A-aquifer)		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		PCBs	MCL	Confirm extent of PCBs
		SVOCs	MCL	Confirm extent of 1,4-dichlorobenzene; Obtain SVOC data to eliminate data gaps
		VOCs	MCL	Confirm attenuation and extent of benzene
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
	IR01MW05A	Aluminum	MCL	Confirm extent of listed metals
		Antimony	HGAL/MCL	
		Arsenic	NAWQC	
		Cadmium	MCL	
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Silver	MCL	
		Zinc	MCL	
		PCBs	MCL	Confirm extent of PCBs
		VOCs	MCL	Confirm attenuation and extent of benzene
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
	IR01MW07A	Nickel	HGAL/NAWQC	Confirm extent of listed metals
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
	IR01MW16A	Aluminum	MCL	Confirm extent of listed metals
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		PCBs	MCL	Confirm extent of PCBs
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of benzene
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
	IR01MW18A	Aluminum	MCL	Confirm extent of listed metals
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		PCBs	MCL	Confirm extent of PCBs
		SVOCs	NAWQC	Confirm extent of phenanthrene

TABLE 4-7

PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-01 (A-aquifer) (cont)	IR01MW18A (cont.)	TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of benzene
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
	IR01MW31A	Lead	HGAL/NAWQC	Confirm extent of lead
		Aluminum	MCL	Confirm extent of aluminum
		PCBs	MCL	Confirm extent of PCBs
		VOCs	MCL	Confirm attenuation and extent of benzene; confirm attenuation and migration of HVOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW38A	VOCs	MCL	Confirm attenuation and extent of benzene
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
	IR01MW42A	Lead	HGAL/NAWQC	confirm extent of listed metals
		VOCs	MCL	Evaluate extent of VOC migration
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
	IR01MW43A	Antimony	HGAL/MCL	Confirm extent of antimony
		PCBs	MCL	Confirm extent of PCBs
		Pesticides	NAWQC	Confirm extent of pesticides; Obtain pesticide data to eliminate data gaps
		SVOCs	MCL	Confirm extent of 1,4-dichlorobenzene; Obtain SVOC data to eliminate data gaps
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of HVOCs, VOCs and benzene
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
	IR01MW48A	Aluminum	MCL	Confirm extent of listed metals
		Barium	MCL	
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Zinc	MCL	
		VOCs	MCL	Confirm attenuation and extent of benzene
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
	IR01MW58A	Barium	MCL	Confirm extent of listed metals
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of benzene
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW62A	Aluminum	MCL	Confirm extent of listed metals
		Antimony	HGAL/MCL	
		Arsenic	NAWQC	
		Barium	MCL	
		Cadmium	MCL	
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	

TABLE 4-7

PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-01 (A-aquifer) (cont)	IR01MW62A (cont.)	Mercury	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		SVOCs	NAWQC	Confirm extent of PAHs and SVOCs
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW63A	Barium	MCL	Confirm extent of barium
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW366A	Cadmium	MCL	Confirm extent of listed metals
		Copper	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		SVOCs	NAWQC	Confirm extent of SVOCs
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW367A	Zinc	MCL	Confirm extent of listed metals
		Pesticides	NAWQC	Confirm extent of pesticides
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of benzene; evaluate VOC migration
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW400A[c]	PCBs	MCL	Confirm extent of PCBs
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW401A	VOCs, SVOCs, metals	--	Evaluate wells at site periphery
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW402A[b]	TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW403A	VOCs, SVOCs, metals	--	Evaluate wells at site periphery
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MWI-2	Aluminum	MCL	Confirm extent of listed metals
		Arsenic	NAWQC	
		Barium	MCL	
		Beryllium	MCL	
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
	IR01MWI-3	Nickel	HGAL/NAWQC	Confirm extent of listed metals
		Zinc	MCL	
		PCBs	MCL	Confirm extent of PCBs
		SVOCs	NAWQC	Confirm extent of PAHs
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of benzene
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MWI-5	Antimony	HGAL/MCL	Confirm extent of listed metals
		Barium	MCL	

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PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-01 (A-aquifer) (cont)	IR01MWI-5 (cont.)	Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		PCBs	MCL	Confirm extent of PCBs and pesticides
		Pesticides	NAWQC	
		SVOCs	NAWQC	Confirm extent of SVOCs
		VOCs	MCL	Confirm attenuation and extent of benzene
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MWI-7[c]	VOCs, SVOCs, metals	--	Evaluate wells near shore
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MWI-8[d]	VOCs, SVOCs, metals	--	Evaluate wells near shore
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MWI-9	Aluminum	MCL	Confirm extent of listed metals
		Antimony	HGAL/MCL	
		Arsenic	NAWQC	
		Barium	MCL	
		Cadmium	MCL	
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Silver	MCL	
		Zinc	MCL	
		PCBs	MCL	Confirm extent of PCBs
		SVOCs	NAWQC	Confirm extent of PAHs; Obtain SVOC data to eliminate data gaps
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		TDS	--	Obtain TDS data for beneficial use analysis
IR-01 (B-aquifer)	IR01MW02B	Aluminum	MCL	Confirm extent of aluminum
		Chromium, Chromium VI	MCL	Confirm the extent of chromium VI and chromium
		SVOCs	NAWQC	Confirm extent of phenanthrene
		VOCs	MCL	Evaluate possible migration from A aquifer
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
	IR01MW09B	TPH	--	Evaluate possible TPH, benzene migration and
		VOCs	MCL	VOCs from A aquifer
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW17B	Aluminum	MCL	Confirm extent of listed metals
		Antimony	HGAL/MCL	

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PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-01	IR01MW17B	Cadmium	MCL	
(B-aquifer)	(cont.)	PCBs	MCL	Evaluate possible PCB and benzene migration
(cont.)		VOCs	MCL	VOCs from A aquifer
		MNA	--	Assess process of natural attenuation
		SVOCs		
			NAWQC	Confirm presence or extent of bis(2-ethylhexyl) phthalate
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW26B[b]	TPH-ext, TPH-purg	--	Evaluate possible TPH, benzene migration and
		VOCs	MCL	VOCs from A aquifer
		SVOCs	NAWQC	Obtain SVOC data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW47B	VOCs	MCL	Confirm extent and attenuation of HVOCs
		SVOCs	NAWQC	Obtain SVOC data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
		TDS	--	Obtain TDS data for beneficial use analysis
	IR01MW53B	Cadmium	MCL	Confirm extent of cadmium
		TPH-ext, TPH-purg	--	Evaluate possible TPH, benzene migration and
		VOCs	MCL	VOCs from A aquifer
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
IR-02	IR01MW44A	Zinc	MCL	Confirm extent of listed metals
(A-aquifer)		PCBs	MCL	Confirm extent of PCBs
		Pesticides	NAWQC	Confirm extent of pesticides
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW89A	Aluminum	MCL	Confirm extent of aluminum and nickel
		Nickel	HGAL/NAWQC	
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near former NRDL sites
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW93A	Nickel	HGAL/NAWQC	Confirm extent of nickel
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW101A1	Aluminum	MCL	Confirm the extent of listed metals and
		Chromium, Chromium VI	MCL	chromium VI
		Nickel	HGAL/NAWQC	
		SVOCs	NAWQC	Confirm extent of pentachlorophenol
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW101A2	Barium	MCL	Confirm extent of listed metals
		Cadmium	MCL	
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW114A1	Cadmium	MCL	Confirm extent of cadmium
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW114A2	Aluminum	MCL	Confirm extent of listed metals
		Cadmium	MCL	
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas

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PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-02 (A-aquifer) (cont.)	IR02MW114A3	Barium	MCL	Confirm extent of listed metals
		Cadmium	MCL	
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW126A	Barium	MCL	Confirm extent of listed metals
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Zinc	MCL	
		PCBs	MCL	Confirm extent of PCBs
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW141A	Aluminum	MCL	Confirm extent of listed metals
		Antimony	HGAL/MCL	
		Barium	MCL	
		Cadmium	MCL	
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Silver	MCL	
		Zinc	MCL	
		PCBs	MCL	Confirm extent of PCBs
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
		SVOCs	NAWQC	Obtain SVOC data to eliminate data gaps
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW147A	SVOCs	NAWQC	Confirm extent of pentachlorophenol
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW149A	Copper	HGAL/NAWQC	Confirm extent of listed metals
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW175A	Aluminum	MCL	Confirm extent of aluminum
		VOCs	MCL	Confirm attenuation and extent of HVOCs
		SVOCs	NAWQC	Obtain SVOC data to eliminate data gaps
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW179A	Cadmium	MCL	Confirm extent of cadmium and nickel
		Nickel	HGAL/NAWQC	
		VOCs	MCL	Confirm extent of VOCs at IR02MW175A
		SVOCs	NAWQC	Confirm extent of pentachlorophenol at IR02MW183A
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
	IR02MW183A	SVOCs	NAWQC	Confirm extent of pentachlorophenol
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW206A1	VOCs	MCL	Confirm extent of VOCs near IR02MW175A
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity

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PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-02 (A-aquifer) (cont.)	IR02MW206A2	VOCs	MCL	Confirm extent of VOCs near IR02MW175A
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
	IR02MW209A	Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium -226 and -228	MCL	Confirm extent of radioactivity
	IR02MW298A	Cadmium	MCL	Confirm extent of metals at IR02MW114A2
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW300A	Copper	HGAL/NAWQC	Confirm extent of listed metals
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		VOCs	MCL	Confirm extent of VOCs near IR02MW175A
		MNA	--	Assess process of natural attenuation
		SVOCs	NAWQC	Obtain SVOC data to eliminate data gaps
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW372A	Pesticides	NAWQC	Confirm extent of pesticides
		VOCs	MCL	Confirm attenuation and extent of benzene and HVOCs
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW373A	Antimony	HGAL/MCL	Confirm extent of listed metals
		Cadmium	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		PCBs	MCL	Confirm extent of PCBs
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MWB-1	Aluminum	MCL	Confirm extent of listed metals
		Arsenic	NAWQC	
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MWB-3	Aluminum	MCL	Confirm extent of listed metals
		Antimony	HGAL/MCL	
		Cadmium	MCL	
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
		SVOCs	NAWQC	Confirm extent of PAHs and Pentachlorophenol Obtain SVOC data to eliminate data gaps
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		TDS	--	Obtain TDS data for beneficial use analysis

TABLE 4-7

PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-02 (B-aquifer)	IR02MW127B	VOCs, pesticides		Assess migration from A aquifer
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near debris disposal areas
		TDS	--	Obtain TDS data for beneficial use analysis
IR-03 A Aquifer	IR02MW97A	Cadmium	MCL	Confirm extent of cadmium
		Chromium, Chromium VI	MCL	Confirm extent of chromium and chromium VI
		Pesticides	NAWQC	Confirm extent of pesticides
		PCBs, VOCs, SVOCs	--	Confirm extent of IR03 plumes:
		Barium, Arsenic, Nickel	--	PCBs, Ba, As, Ni, VOCs, pentachlorophenol
		TPH-ext, TPH-purg	--	and TPH
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW146A	PCBs	MCL	Confirm extent of PCBs
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of benzene
		SVOCs	NAWQC	Confirm extent of IR03 plumes: pentachlorophenol,
		Barium, Arsenic, Nickel	--	listed metals, VOCs, and PCBs
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW173A[e]	Arsenic	NAWQC	Confirm extent of listed metals
		Barium	MCL	
		SVOCs	NAWQC	Confirm extent of phenanthrene
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of benzene
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MW299A	Copper	HGAL/NAWQC	Confirm extent of listed metals
		VOCs	MCL	Confirm attenuation and extent of HVOCs
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR02MWB-5	Nickel	HGAL/NAWQC	Confirm extent of listed metals
		PCBs	MCL	Confirm extent of PCBs
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR03MW218A1[e]	Barium	MCL	Confirm extent of listed metals
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		PCBs	MCL	Confirm extent of PCBs
		SVOCs	NAWQC	Confirm extent of phenanthrene
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR03MW218A2	Barium	MCL	Confirm extent of listed metals
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Zinc	MCL	
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of benzene
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis

TABLE 4-7

PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-03 (A-aquifer) (cont.)	IR03MW218A3	Barium	MCL	Confirm extent of barium
		VOCs	MCL	Confirm attenuation and extent of benzene
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR03MW224A	Aluminum	MCL	Confirm extent of listed metals
		Chromium, Chromium VI	MCL	Confirm extent of chromium and chromium VI
		Copper	HGAL/NAWQC	
		TPH-ext, TPH-purg	--	Confirm extent of IR03 contamination: SVOCs,
		SVOCs	NAWQC	VOCs, TPH, arsenic, barium, nickel; obtain
		VOCs	MCL	SVOC data to eliminate data gaps
		Arsenic, barium, nickel	--	
		MNA	--	Assess process of natural attenuation
		PCBs	MCL	Confirm extent of PCBs
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
	IR03MW225A[e]	Nickel	HGAL/NAWQC	Confirm extent of listed metals
		PCBs	MCL	Confirm extent of PCBs
		SVOCs	--	Confirm extent of SVOCs
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm extent of HVOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
	IR03MW226A[e]	Aluminum	MCL	Confirm extent of listed metals
		Antimony	HGAL/MCL	
		Barium	MCL	
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		PCBs	MCL	Confirm extent of PCBs
		SVOCs	NAWQC	Confirm extent of phenanthrene
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of HVOCs and benzene
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
	IR03MW342A	Aluminum	MCL	Confirm extent of listed metals
		Arsenic	NAWQC	
		Barium	MCL	
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		TPH-ext, TPH-purg	--	Confirm extent of IR03 plumes: pentachlorophenol,
		SVOCs	NAWQC	PCB and TPH
		VOCs	MCL	Confirm attenuation and extent of benzene
		PCBs	MCL	and IR03 plumes
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis

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PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-03 (A-aquifer) (cont.)	IR03MW369A[e]	SVOCs	NAWQC	Confirm extent of phenanthrene
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of benzene
		PCBs	MCL	Confirm extent of IR03 plumes: pentachlorophenol,
		Barium, Arsenic, Nickel	--	listed metals, VOCs, PCBs and TPH
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
	IR03MW370A[e]	Barium, Arsenic, Nickel	--	Confirm extent of barium and metals at IR03 plume
		PCBs	MCL	Confirm extent of PCBs from IR03 plume
		SVOCs	NAWQC	Confirm extent of phenanthrene
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of benzene
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
	IR03MW371A	PCBs	MCL	Confirm extent of PCBs
		VOCs	MCL	Confirm extent of IR03 plumes: pentachlorophenol,
		SVOCs	NAWQC	listed metals, VOCs, PCBs and TPH
		Barium, Arsenic, Nickel	--	
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
	IR03MWO-1[e]	Aluminum	MCL	Confirm extent of listed metals and of IR03 plume
		Arsenic	NAWQC	
		Barium	MCL	
		Chromium, Chromium VI	MCL	
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		Nickel	HGAL/NAWQC	
		Zinc	MCL	
		PCBs	MCL	Confirm extent of PCBs
		SVOCs	NAWQC	Confirm extent of SVOCs
		VOCs	MCL	Confirm attenuation and extent of benzene
			--	Confirm attenuation and extent of HVOCs
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Confirm extent of radioactivity
		Radium-226 and -228	MCL	Confirm extent of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
IR-03 (B-aquifer)	IR02MW210B	VOCs	MCL	Evaluate possible HVOC migration from A aquifer
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
	IR03MW228B	Cadmium	MCL	Confirm extent of cadmium
		Barium	MCL	Evaluate migration from A aquifer
		VOCs	MCL	Evaluate migration from A aquifer
		SVOCs	NAWQC	Obtain SVOC data to eliminate data gaps
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate migration of radioactivity
		TDS	--	Obtain TDS data for beneficial use analysis
IR-04 (A-aquifer)	IR04MW13A	VOCs	MCL	Confirm attenuation and extent of HVOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR04MW31A	Arsenic	NAWQC	Confirm extent of arsenic
		VOCs	MCL	Evaluate migration from A aquifer
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR04MW35A	Nickel	HGAL/NAWQC	Confirm extent of nickel
		VOCs	MCL	Confirm attenuation and extent of HVOCs

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PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-04 (A-aquifer) (cont.)	IR04MW35A (cont.)	MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR04MW36A	Arsenic	NAWQC	Confirm extent of arsenic
		TDS	--	Obtain TDS data for beneficial use analysis
	IR04MW37A	VOCs	MCL	Confirm attenuation and extent of HVOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR04MW38A	VOCs	MCL	Evaluate potential for VOC migration
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR04MW39A	VOCs	MCL	Confirm attenuation and extent of HVOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR04MW40A	Lead	HGAL/NAWQC	Confirm extent of listed metals
		Nickel	HGAL/NAWQC	
		Cadmium	MCL	
		TDS	--	Obtain TDS data for beneficial use analysis
	PA50MW10A	Cadmium	MCL	Confirm extent of listed metals
		Copper	HGAL/NAWQC	
		Lead	HGAL/NAWQC	
		Zinc	MCL	
		VOCs	MCL	Evaluate possible migration of VOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
IR-05 (A-aquifer)	IR05MW73A	PCBs	MCL	Confirm extent of PCBs
		TDS	--	Obtain TDS data for beneficial use analysis
	IR05MW77A	Lead	HGAL/NAWQC	Confirm extent of lead
		TDS	--	Obtain TDS data for beneficial use analysis
	IR05MW85A	Arsenic	NAWQC	Confirm extent of listed metals
		Cadmium	MCL	
		Copper	HGAL/NAWQC	
		Mercury	HGAL/NAWQC	
		SVOCs	NAWQC	Confirm extent of phenanthrene
		TDS	--	Obtain TDS data for beneficial use analysis
IR-11 (A-aquifer)	IR11MW25A	VOCs	MCL	Confirm attenuation and extent of HVOCs
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR11MW26A	VOCs	MCL	Confirm attenuation and extent of HVOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR11MW27A	Copper	HGAL/NAWQC	Confirm extent of copper
		VOCs	MCL	Confirm attenuation and extent of HVOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
IR-12 (A-aquifer)	IR12MW11A	VOCs	MCL	Evaluate potential for VOC migration
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR12MW13A	VOCs	MCL	Confirm attenuation and extent of HVOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR12MW14A	VOCs	MCL	Evaluate potential for VOC migration
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR12MW17A	Barium	MCL	Confirm extent of barium
		TPH-ext, TPH-purg	--	Confirm attenuation and extent of TPH
		VOCs	MCL	Confirm attenuation and extent of HVOCs
				Confirm extent and attenuation of benzene
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis

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PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-12	IR12MW18A	Arsenic	NAWQC	Confirm extent of listed metals
(A-aquifer)		Nickel	HGAL/NAWQC	
(cont.)		VOCs	MCL	Evaluate potential for VOC migration
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR12MW19A	VOCs	MCL	Confirm attenuation and extent of HVOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR12MW20A	Arsenic	NAWQC	Confirm extent of arsenic
		VOCs	MCL	Evaluate potential for VOC migration
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near former NRDL sites
	IR12MW21A[e]	Arsenic	NAWQC	Confirm extent of listed metals
		Barium	MCL	
		Cadmium	MCL	
		VOCs	MCL	Evaluate possible HVOC migration
		TPH-ext, TPH-purg	--	Confirm extent and attenuation of TPH
		SVOCs	NAWQC	Obtain SVOC data to eliminate data gaps;
				Confirm extent of phenanthrene
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
IR-14	IR14MW09A	Mercury	HGAL/NAWQC	Confirm extent of listed metals
(A-aquifer)		Nickel	HGAL/NAWQC	
		TPH-ext, TPH-purg	--	Confirm extent of TPH contamination from IR14MW13A and IR15MW08A plume
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near former NRDL sites
		TDS	--	Obtain TDS data for beneficial use analysis
	IR14MW10A	Antimony	HGAL/MCL	Confirm extent of listed metals
		Cadmium	MCL	
		Lead	HGAL/NAWQC	
		PCBs	MCL	Confirm extent of IR03 plumes including
		VOCs	MCL	PCBs, barium, arsenic, nickel, VOCs
		SVOCs	NAWQC	and pentachlorophenol
		MNA	--	Assess process of natural attenuation
		Barium, Arsenic, Nickel	--	
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near former NRDL sites
		TDS	--	Obtain TDS data for beneficial use analysis
	IR14MW12A	Cadmium	MCL	Confirm extent of cadmium and nickel
		Nickel	HGAL/NAWQC	
		TPH-ext, TPH-purg	--	Confirm extent of TPH contamination from IR14MW13A and IR15MW08A plume
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near former NRDL sites
		TDS	--	Obtain TDS data for beneficial use analysis
	IR14MW13A	Barium	MCL	Confirm extent of barium
		SVOCs	NAWQC	Confirm extent of phenanthrene
		TPH-ext, TPH-purg	--	Confirm extent and attenuation of TPH
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near former NRDL sites

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PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA

IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-14 (A-aquifer) (cont.)	IR15MW06A	Lead	HGAL/NAWQC	Confirm extent of listed metals
		Thallium	HGAL/MCL	
		VOCs	MCL	Confirm attenuation and extent of HVOCs
		MNA	--	Assess process of natural attenuation
		TPH-ext, TPH-purg	--	Confirm extent of TPH contamination at IR14MW13A and IR15MW08A plume
		TDS	--	Obtain TDS data for beneficial use analysis
	IR15MW07A	Lead	HGAL/NAWQC	Confirm extent of lead and silver
		Silver	MCL	
		TPH-ext, TPH-purg	--	Confirm extent of TPH contamination at IR14MW13A and IR15MW08A plume
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near former NRDL sites
		TDS	--	Obtain TDS data for beneficial use analysis
	IR15MW08A	TPH-ext, TPH-purg	--	Confirm extent and attenuation of TPH
		MNA	--	Assess process of natural attenuation
		SVOCs	NAWQC	Confirm extent of phenanthrene; Obtain SVOC data to eliminate data gaps
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near former NRDL sites
		TDS	--	Obtain TDS data for beneficial use analysis
IR-15 (Bedrock)	IR15MW09F	VOCs	MCL	Evaluate potential for VOC migration
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near former NRDL sites
		TDS	--	Obtain TDS data for beneficial use analysis
	IR15MW10F	Arsenic	NAWQC	Confirm extent of arsenic
		VOCs	MCL	Evaluate potential for VOC migration
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
IR-36 (A-aquifer)	IR36MW11A	TPH-ext, TPH-purg	--	Confirm extent and attenuation of TPH
		VOCs	MCL	Evaluate potential for VOC migration
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near former NRDL sites
		TDS	--	Obtain TDS data for beneficial use analysis
	IR36MW12A	TPH-ext, TPH-purg	--	Confirm extent and attenuation of TPH
		MNA	--	Assess process of natural attenuation
		Gross Alpha, Gross Beta	MCL	Evaluate radioactivity near former NRDL sites
		TDS	--	Obtain TDS data for beneficial use analysis
	IR36MW14A	VOCs	MCL	Confirm extent of VOCs to the north
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR36MW125A	VOCs	MCL	Confirm attenuation and extent of HVOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR36MW126A	VOCs	MCL	Evaluate possible HVOC migration other wells
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR36MW127A	VOCs	MCL	Evaluate possible HVOC migration other wells
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR36MW128A	VOCs	MCL	Confirm extent of VOCs to the north
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR36MW135A	Cadmium	MCL	Confirm extent of cadmium
		TDS	--	Obtain TDS data for beneficial use analysis
	PA36MW03A[d]	Copper	HGAL/NAWQC	Confirm extent of listed metals
		Zinc	MCL	
		Pesticides	NAWQC	Confirm extent of 4,4 DDT
		TDS	--	Obtain TDS data for beneficial use analysis

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PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Criteria of Concern[a]	Rationale for Resampling[f]
IR-36 (A-aquifer) (cont.)	PA36MW04A	Copper	HGAL/NAWQC	Confirm extent of copper
		Pesticides	NAWQC	Confirm extent of pesticides
		VOCs	MCL	Confirm extent or attenuation of HVOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	PA36MW07A	Pesticides	NAWQC	Confirm reduction of heptachlor
		VOCs	MCL	Confirm extent or attenuation of HVOCs
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	PA36MW08A	TPH-ext, TPH-purg	--	Confirm extent and attenuation of TPH
		SVOCs	NAWQC	Obtain SVOC data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR39MW21A	Antimony	HGAL/MCL	Confirm extent of antimony
		Pesticides	NAWQC	Confirm extent of heptachlor; Obtain pesticides data to eliminate data gaps
		VOCs	MCL	Confirm extent or attenuation of benzene
		MNA	--	Assess process of natural attenuation
		SVOCs	NAWQC	Obtain SVOC data to eliminate data gaps
		PCBs	MCL	Confirm extent of PCBs
		TDS	--	Obtain TDS data for beneficial use analysis
	IR39MW23A	Aluminum	MCL	Confirm extent of aluminum
		TDS	--	Obtain TDS data for beneficial use analysis
	IR39MW33A	Barium	MCL	Confirm extent of barium
		VOCs	MCL	Confirm extent and attenuation of benzene
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
IR-36 (B-aquifer)	IR36MW120B	VOCs	MCL	Evaluate possible HVOC migration from A aquifer
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR36MW123B	VOCs	MCL	Evaluate possible HVOC migration from A aquifer
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
	IR36MW129B	VOCs	MCL	Evaluate possible HVOC migration from A aquifer
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
IR-56 (A-aquifer)	IR56MW39A	TPH-ext, TPH-purg	--	Confirm extent and attenuation of TPH
		VOCs	MCL	Confirm extent and attenuation of benzene
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis
IR-72 (A-aquifer)	IR72MW32A	TPH-ext, TPH-purg	--	Confirm extent and attenuation of TPH
		VOCs	MCL	Evaluate possible migration of VOCs
		SVOCs	NAWQC	Obtain SVOC data to eliminate data gaps
		MNA	--	Assess process of natural attenuation
		Pesticides	NAWQC	Obtain pesticide data to eliminate data gaps
		TDS	--	Obtain TDS data for beneficial use analysis
IR-73 (A-aquifer)	IR73MW04A	TPH-ext, TPH-purg	--	Confirm extent and attenuation of TPH
		MNA	--	Assess process of natural attenuation
		TDS	--	Obtain TDS data for beneficial use analysis

PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
(Page 15 of 15)

Notes:

a Criteria of concern are NAWQC or the lower of the state or federal MCLs, where above HPGALs. Criteria listed are lower criteria for the contaminants of concern.

b These wells have not been located, and may not be available for sampling. Additional wells will be sampled if appropriate and/or new wells will be installed as necessary.

c The lids of these wells could not be opened during the well condition survey, and may not be available for sampling. Additional wells will be sampled if appropriate and/or new wells will be installed as necessary.

d This well was silted more than 50 percent, and may not be possible to sample. Redevelopment will be attempted. If not successful, a new well will be installed.

e These wells have viscous free product, and may not be possible to sample.

f A detailed rationale for identifying data gaps at Parcel E is included in Appendix B of the FSP addendum; meeting minutes from the November 7, 2000 Parcel E groundwater evaluation meeting are also included in Appendix B.

1 MNA parameters include reduced metals iron (II) and iron (III), calcium, magnesium, sodium, potassium, manganese (II), methane, ethane, ethene, nitrate, nitrite, sulfate, dissolved oxygen, oxygen reduction potential, chloride, total alkalinity, carbonate, bicarbonate, hydroxide alkalinity, and TDS. The wells indicated for MNA analysis will be sampled as feasible, but the total number of wells to be sampled may be reduced based on field conditions.

2 One well, IR02MWB-2, was eliminated from sampling because it was abandoned.

HGAL Hunters Point groundwater ambient level
HVOC Halogenated volatile organic compound
MCL Maximum contaminant limit
MNA Monitored natural attenuation (see note 1)
NAWQC National Ambient Water Quality Criteria (see note 2)
NRDL Naval Radiological Defense Laboratory
PAH Polycyclic aromatic hydrocarbon
PCB Polychlorinated biphenyl
SVOC Semivolatile organic compound
TDS Total dissolved solids
TPH-ext Total petroleum hydrocarbons, extractables
TPH-purg Total petroleum hydrocarbons, purgeables
VOC Volatile organic compound

TABLE 8-1

SCHEDULE
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Event	Beginning Date	Ending Date
Phase II (Parcels C, D, & E)		
Submit Informational Document for Parcel E	October 16, 2000	October 16, 2000
BCT Review Period	October 16, 2000	November 6, 2000
BCT Comments Due	November 6, 2000	November 6, 2000
Parcel E Groundwater Meeting	November 7, 2000	November 7, 2000
Phase I Information Analysis Meeting/Phase II Scoping Meeting	December 5, 2000	December 5, 2000
Prepare Phase II FSP/QAPP Addendum - Parcels C, D, & E	December 5, 2000	January 8, 2001
Submit Phase II FSP/QAPP Addendum - Parcels C, D, & E	January 8, 2001	January 8, 2001
BCT Review Period	January 8, 2001	January 22, 2001
BCT Phase II Concurrence Meeting (tentative)	January 25, 2001	January 25, 2001
Submit Revised Phase II FSP/QAPP Addendum - Parcels C, D, & E (tentative date—if necessary based on 1/25/01 meeting)	February 1, 2001	February 1, 2001
Parcel D		
Phase II Sampling	January 26, 2001	February 26, 2001
Lab Analysis/Data Management & Review	February 27, 2001	May 8, 2001
Submit Phase II Information Package to BCT	May 8, 2001	May 8, 2001
BCT Review Period	May 8, 2001	May 22, 2001
BCT Comments Due	May 22, 2001	May 22, 2001
Phase II Information Analysis Meeting (tentative)	May 29, 2001	May 29, 2001
Parcel C		
Phase II Sampling	January 26, 2001	March 19, 2001
Lab Analysis/Data Management & Review	March 20, 2001	May 29, 2001
Submit Phase II Information Package to BCT	May 29, 2001	May 29, 2001
BCT Review Period	May 29, 2001	June 12, 2001
BCT Comments Due	June 12, 2001	June 12, 2001
Phase II Information Analysis Meeting (tentative)	June 19, 2001	June 19, 2001

TABLE 8-1 (Continued)

SCHEDULE
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 2 of 2)

Event	Beginning Date	Ending Date
Parcel E		
Phase II Sampling	January 26, 2001	March 15, 2001
Lab Analysis/Data Management & Review	March 16, 2001	May 24, 2001
Prepare Beneficial Use Letter	May 24, 2001	June 23, 2001
Submit Phase II Information Package & Ben. Use Letter to BCT	June 23, 2001	June 23, 2001
BCT Review Period	June 23, 2001	July 7, 2001
BCT Comments Due	July 7, 2001	July 7, 2001
Phase II Information Analysis Meeting (tentative)	July 13, 2001	July 13, 2001

Notes:

BCT Base Realignment and Closure Cleanup Team
FSP Field sampling plan
QAPP Quality assurance project plan

APPENDIX A

FINAL FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN
PHASE I GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(dated July 31, 2000, provided on CD-ROM only)

APPENDIX B

SUMMARY OF GROUNDWATER WORKING MEETINGS

PARCEL E GROUNDWATER DATA GAP MEETING MINUTES
HUNTERS POINT SHIPYARD
November 7, 2000

These minutes summarize the Hunters Point Shipyard (HPS) Parcel E groundwater data gap meeting. The meeting was held on November 7, 2000, at the California Regional Water Quality Control Board (RWQCB) office in Oakland, California. The meeting was attended by the Base Realignment and Closure (BRAC) Cleanup Team (BCT), comprised of the Navy, the U.S. Environmental Protection Agency (EPA), the California Department of Toxic Substances Control (DTSC), and the RWQCB. The meeting was also attended by the Navy's consultants, and the City of San Francisco (City). A list of attendees is included as Attachment A to these minutes. These minutes discuss the key points, decisions, and action items agreed to at the meeting. A complete list of action items is included as Attachment B to these minutes.

INTRODUCTION

The Navy submitted a Parcel E groundwater data gap packet to the BCT on October 16, 2000. The packet included:

- Screening criteria the Navy used to determine groundwater data gaps
- Results of the data screening
- A list of wells the Navy believes should be sampled
- Maps representing groundwater wells and data on Parcel E

The purpose of the meeting was to obtain feedback from the BCT on the Navy's groundwater data gap strategy, so the Navy can incorporate BCT comments into the Phase II groundwater data gap sampling and analysis plan addendum, which is planned for submittal to the BCT on January 8, 2001. Data obtained from the data gap sampling will be utilized in development of the revised Parcel E feasibility study.

REVIEW OF GROUNDWATER DATA GAP PACKET

The Navy proposed to select groundwater monitoring wells for sampling if a well had an exceedance of the screening criteria, except where the last two rounds of sampling had non-detect analytical results. The screening criteria used for that selection process were the maximum contaminant levels (MCL) for drinking water and the national ambient water quality criteria (NAWQC) standards. In addition, the Navy proposed to sample a B-aquifer well if there had been an exceedance in a nearby A-aquifer well, and to sample VOCs where there may have been an elevated hit in the past.

The BCT is concerned that the Navy might be screening out data where the detection limit was above the screening criteria. The BCT stated that all exceedances of the screening criteria, including those wells where the detection limit was above the screening criteria, should require a well to be sampled. The Navy proposed to look at any exceedance, including those wells where the detection limit was above the screening criteria, on a case-by-case basis and to make recommendations in the Phase II groundwater data gap sampling plan. The BCT concurred with the Navy, and recommended the Navy look at spatial and temporal issues, however, the EPA clarified that spatial distribution of wells will only allow wells to be dropped for sampling if the source of the contaminant release is known.

The BCT requested clarification on how the Navy will determine whether the older wells are still acceptable for sampling. The Navy stated that it conducted a base wide well inspection and will follow the previous strategy for redeveloping wells as was performed for the Phase I groundwater data gap sampling.

The BCT noted that they are not only concerned about sampling groundwater wells within the landfill cap area where the landfill fire may have changed the chemical composition, but are also concerned about sampling wells which are up gradient and downgradient from the landfill. The DTSC requested that the Navy sample for metals at IR-01, groundwater monitoring well IR01MW05A.

Installation Restoration Site (IR) 03

The Navy proposed to collect groundwater analytical data below the free product at IR-03 for the feasibility study, since it may not be technically and economically practical to remove the free product and it may not be affecting the groundwater below it. The RWQCB stated that they prefer the free product at IR-03 be removed, but concurred with the Navy's strategy on sampling wells within IR-03 and also requested that the Navy determine the horizontal and vertical extent of contamination. The Navy will also verify that water levels have been corrected for free product.

Soil/Groundwater Screening

The BCT is concerned that the Navy has not proposed soil screening criteria for use in identifying overlying contaminated soil, which might impact groundwater quality. The Navy clarified that it is planning to address this issue in the soil data gap work plan. The BCT recommended that the Navy consider conducting leachability tests. The Navy is evaluating this request.

Review of Specific Navy Recommendations

DTSC distributed their preliminary well-by-well recommendations. The BCT reviewed the Parcel E groundwater data packet on a well-by-well basis at the meeting. The Navy will include specific agreements with the BCT in the Phase II groundwater data gap sampling and analysis plan. Detailed notes on these discussions are not included in these minutes; however, general issues are noted in the following text.

The BCT was concerned whether the Navy was proposing to sample for chromium VI in areas where chromium was of concern. The Navy clarified that their proposal includes the analysis for chromium VI in all areas where chromium is an analyte to be sampled.

The BCT requested that the Navy sample for fire-related constituents during the data gap sampling effort. The Navy believes that their proposal incorporates that sampling, but will check to make sure all applicable wells and appropriate analytes are included in the Phase II groundwater data gap sampling and analysis plan.

The BCT noted that the screening criteria tables were confusing as presented in the Navy's groundwater data gap packet. The Navy proposed to revise that table to clarify this issue and will show the most appropriate screening criteria (similar to the Parcel B ESD table).

The BCT requested that the Navy add subsurface and surface structures to the groundwater contour maps, where appropriate, in order to aid in the understanding of groundwater flow directions. The Navy agreed to add this information to future maps, and are also performing additional sampling to verify that the groundwater pumping and sheet pile wall are working as originally planned. DTSC requested that the Navy include a description of the data gaps and explain how these data gaps will be filled. The Navy agreed.

The BCT requested a well construction table in the Phase II data gap work plan to include new wells and well material (especially stainless steel). The Navy prefers to refer to the remedial investigation report for these previously submitted tables.

Micropurging and Well Stabilization

The Navy stated that they have not been successful using micropurge, because extremely low pumping rates were used in order to avoid lowering the water table in the wells below acceptable levels (per EPA's micropurging criteria). The length of time required to purge wells at these low pumping rates was not practical. The Navy proposed to use low-flow sampling to avoid the stabilization problem. The BCT prefers the micropurge method. With regard to the Navy's no-purge proposal, the BCT will review a set of analytical data from wells that were purged and wells that were not purged. The Navy will check into the feasibility of obtaining this data set. DTSC requested that the Navy use the stabilization criteria from Puls & Barcelona. The Navy noted that the Puls and

Barcelona stabilization criteria were adhered to and that it took approximately 6 hours for stabilization using that method.

Beneficial Reuse Letter

The BCT wanted to know how data collected from the Phase II sampling effort will be incorporated into the Navy's beneficial use letter. The Navy clarified that it will include new data for Parcels C and D, and old data for Parcel E in the letter. The Navy will only propose to revise the beneficial use lines if the total dissolved solids (TDS) results from new sampling events change significantly from previous sampling events. The BCT requested clarification on which TDS value the Navy proposed using for the beneficial use letter. The Navy clarified that it proposes using the highest TDS value from any sampling event, which is consistent with the June 2000 Final Determination of Beneficial Uses of Groundwater for Alameda Point. The RWQCB expressed concern over TDS stratification in the monitoring wells but concurred that the highest TDS values should be used in this evaluation.

The City requested clarification whether the Navy was attempting to change the RWQCB's basin plan by issuing its beneficial use letter. The Navy clarified it is not attempting to change the basin plan through the beneficial use letter.

The Navy had also included a handout describing the tidal effects at HPS. However, this was not discussed at the meeting.

ATTACHMENT A

LIST OF ATTENDEES

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ATTACHMENT B

HPS BCT ACTION ITEMS

Action	Date Identified	Responsible Party	Date Due	Date Accomplished	Notes
Parcel E. The Navy will check into the feasibility of obtaining an analytical data set of purged and non-purged wells.	07-Nov-00	Richard Mach (Navy)	08-Jan-01		Will be in Draft Phase II SAP.
Parcel E. The Navy will evaluate whether DLs exceed screening criteria and will reevaluate recommendations accordingly.	07-Nov-00	Richard Mach (Navy)	08-Jan-01		Will be in Draft Phase II SAP.
Parcel E. The Navy will check whether GW levels have been corrected for free product, and will revise levels if necessary.	07-Nov-00	Richard Mach (Navy)	08-Jan-01		Will be in Draft Phase II SAP.
Parcel E. The Navy will check landfill wells to ensure all appropriate wells and analytes are included in the Phase II SAP.	07-Nov-00	Richard Mach (Navy)	08-Jan-01		Will be in Draft Phase II SAP.
Parcel E. The Navy will revise GW contour maps to include sub-surface structures.	07-Nov-00	Richard Mach (Navy)	08-Jan-01		Will be in Draft Phase II SAP.
Parcel E. The Navy will perform performance testing on the sheet pile wall (separate from the Phase II SAP).	07-Nov-00	Richard Mach (Navy)	TBD		Contract awarded. Schedule being addressed.

PARCELS C AND D PHASE I GROUNDWATER DATA GAP MEETING
HUNTERS POINT SHIPYARD
MEETING MINUTES
December 5, 2000

These minutes summarize discussions regarding Parcels C and D Phase I groundwater data gap results at Hunters Point Shipyard (HPS), California. The meeting was held at 12:30 p.m. on December 5, 2000, at the Tetra Tech EM Inc. (TtEMI) office in San Francisco, California. The meeting was attended by members of the Base Realignment and Closure (BRAC) Cleanup Team (BCT), including the Navy, the U.S. Environmental Protection Agency (EPA), the San Francisco Regional Water Quality Control Board, and the California Department of Toxic Substances Control (DTSC). The meeting was also attended by the City of San Francisco (City), and its team of developers. A list of attendees is included as Attachment A to these minutes. These minutes discuss the key points, decisions, and action items agreed to at the meeting.

REVIEW AGENDA

The Navy distributed the following agenda to the BCT at the meeting. The BCT concurred with the proposed agenda.

Background Information
- Summary of Technical Memorandum submitted on December 1, 2000
- Four Elements of Work

Well Inspection Program
- Progress to date
- DQO comparison / recommendations

Water Level Measurements
- Progress to date
- DQO comparison / recommendations

B-aquifer Investigation
- Progress to date
- Summary of results – Parcel D, only
- DQO comparison / recommendations

A-aquifer Investigation
- Progress to date
- Summary of results
- DQO comparison / recommendations

Environmental Visualization System (EVS) Discussion
- EVS and the remedial unit (RU) conceptual model
- Demonstration

BACKGROUND INFORMATION

The Navy noted that the Phase I data package submitted on December 1, 2000 would be revised to improve the data presentation and would be re-submitted on January 8, 2001, in conjunction with the Phase II field sampling plan and quality assurance project plan (FSP/QAPP) addendum. The Navy noted that the revised Phase I data package would be referenced in the Parcel D feasibility study (FS). The BCT noted they have not fully reviewed the Phase I data package submittal and any comments made during this meeting are not final comments. The BCT was concerned about the 14-day review time for the Phase II groundwater data gap FSP/QAPP addendum; however, if most information discussed in the meeting is included in that plan, the proposed 14-day review period may be acceptable.

The Navy is in the process of implementing its four-element groundwater data gaps investigation. The four elements and their status are as follows:

- First element – well inspection/repair: this work began in March 2000 and is almost complete
- Second element – water level measurements: the first round of a-aquifer measurements has been completed
- Third element – B-aquifer investigation: new wells were installed at Parcels C and D from September through December 2000 (two wells still to be installed at Parcel C). All new wells at Parcel D were sampled in October 2000
- Fourth element – A-aquifer investigation: existing A-aquifer wells at Parcel C and D were sampled during August and October 2000

The Navy proposes to use the environmental visualization system program that allows one to look at geology and groundwater contamination in a three-dimensional perspective. The BCT agreed that this would be a good tool to utilize; however, the BCT still wants hard copies for the public and themselves.

WELL INSPECTION PROGRAM

The Navy began the well inspection program before the preparation of the Phase I FSP/QAPP. Data from inspection program (for example, depth of accumulated sediment, presence of free product) was included in Phase I FSP/QAPP. The well inspection program included light maintenance consisting of replacement of locks, and locking well caps, as necessary. Additional maintenance consisting of well vault replacement was performed within the past three months.

Prior to the Phase I sampling effort, five wells in Parcel C required redevelopment prior to sampling, and no wells in Parcel D required redevelopment. No video logging of wells occurred. Silt levels in some wells (notably Parcel E wells) have exceeded 50 percent of the well screens depth, and may be recommended by the Navy for abandonment or replacement, if necessary, in the future. The BCT stated that it does not believe that all wells with silt accumulated in more than 50% of the screen interval should be abandoned, and that well abandonment should be performed on a case-by-case basis. The Navy stated that specific recommendations for well abandonment and potential replacement would be discussed with the BCT prior to implementation. In addition, the Navy will not propose abandonment of wells on Parcel E until updated groundwater data is collected under Phase II of the data gaps investigation.

The BCT is concerned about soil to groundwater contamination issues on Parcels C and D. The Navy proposes to look at the most conservative screening values, which are being prepared as part of a Parcel E soil data gap effort.

WATER LEVEL MEASUREMENTS

The Navy plans to replicate the July 2000 basewide water level measurement event for the Phase II data gaps investigation. The Navy may propose to include several additional wells to the Phase II water level measurement event (to be specified in Phase II FSP/QAPP addendum). The Navy distributed hard copies of two documents to supplement the Phase I data package as follows: (1) a revised version of Figure 6, "A-Aquifer Groundwater Elevations, July 12, 2000," and (2) new Table 3, "Summary of Groundwater Screening Criteria." The revised Figure 6 and the new Table 3 will also be submitted as part of the revised Phase I data package on January 8, 2001.

The Navy discussed that A-aquifer groundwater elevation anomalies from the July 12, 2000 measurement event (and other historic measurement events) would be further evaluated, as outlined in the data quality objectives in the Phase I FSP/QAPP. However, the Navy clarified that numerous repairs to water supply lines at HPS have been conducted since the July 12, 2000 event (and will continue as more leaks are identified). These repairs are likely to affect the A-aquifer groundwater elevations. The BCT expressed concern over sanitary line influence in Parcel D and E. Navy stated they would pursue evaluation of such groundwater sinks in contaminant plume areas.

A-AQUIFER AND B-AQUIFER INVESTIGATION

Parcel D

The Navy stated that all B-aquifer wells at Parcel D have been installed, developed, and sampled. The results are presented in the Phase I data package. In addition, the Navy distributed a 2-page table summarizing the chemical results (for the analytes of concern) from the new B-aquifer wells and the paired A-aquifer wells (if present). Based on the existing chemical data, the B-aquifer concentrations of the analytes of concern are below the applicable screening criteria. One new B-aquifer well at Parcel D (and its paired A-aquifer well) had elevated levels of thallium that were not consistent with previously detected concentrations in the near vicinity. The thallium exceedances will be further evaluated, if necessary, after Phase II of the investigation.

The Navy believes that the existing B-aquifer well coverage is sufficient since their selection was based on known contaminant concentrations in the A-aquifer. The Phase I A-aquifer results show that contaminant concentrations are generally consistent with previously detected concentrations, and that there is no evidence of contaminant migration either within the A-aquifer or to the B-aquifer. Navy recommends the collection of a second round of data at new B-aquifer wells to verify the Phase I results, but does not recommend the installation of any additional B-aquifer wells at Parcel D. In addition, a more detailed evaluation of the B-aquifer hydrogeology will be presented in the Phase II information package to verify that the existing B-aquifer wells adequately characterize the B-aquifer.

The Navy explained that the Phase I water level measurements to evaluate vertical gradient were limited by number of existing paired A- and B-aquifer wells and were not sufficient to provide a detailed evaluation. Further evaluation will be conducted in Phase II at the existing and newly installed A- and B-aquifer well pairs.

Parcel C

The Navy stated that all new A-aquifer wells and the majority of new B-aquifer wells at Parcel C have been installed. Development of the new wells is ongoing, and installation of the remaining wells will be completed shortly. All new wells at Parcel C will be sampled for the first time during the Phase II sampling activities. In addition to the newly installed wells at Parcel C, the Navy proposes the installation of several additional A-aquifer and B-aquifer wells at volatile organic compound (VOC)-impacted areas at Parcel C.

The Navy proposed adding one new B-aquifer well for Phase II at IR-25 between buildings 123 and 134 to help identify local lithology, since a bedrock rise was found to exist there.

The Navy installed an additional well in IR06 (well IR06MW59A) as part of Phase I that is located adjacent to the north sidewall of excavation A-1 (where vinyl chloride was detected in the soil during remedial action activities). The new well was screened at the bottom of the A-aquifer sediment and did not detect vinyl chloride; however, lithologic conditions at the excavation suggest the potential presence of a perched water zone within the A-aquifer. An additional A-aquifer well screened in the upper portion of the A-aquifer is proposed for Phase II to evaluate the extent of potential vinyl chloride contamination.

The BCT requested additional data on the maps or in tables, including building numbers, existing plumes with designations, plumes based on recent sampling, the flow direction near areas of concern, areas where other work is occurring (i.e., chemical oxidation and soil vapor extraction), wells that were not sampled, and cross-parcel hits (data at adjacent parcel boundaries for data presentation). The Navy will try to get as much of this information into the revised data packet.

The BCT requested clarification on new well diameters. The Navy stated that all new wells are 4-inch diameter wells. The BCT requested clarification when chemical oxidation data would be collected. The Navy will collect data frequently, throughout the treatment process and will update the BCT frequently via weekly tracking tables and monthly BCT meetings once the system is in place. The Navy originally planned to include chemical oxidation information in the feasibility study; however, the Navy is open to submitting another secondary document with this information. As more data is generated during this process, the data will go into the same database and be included in the data packets sent with the phased data gap program. The BCT stated it also wishes to review the chemical oxidation data as it is collected. The Navy agreed.

The BCT requested to add total dissolved solids (TDS) sampling to the Phase II program, since they have concerns over TDS data utilized in the beneficial use letter, especially if the previous samples were collected immediately after development of the well. The Navy agreed to double-check TDS data used for the beneficial use letter. The Navy asked BCT for clarification of moving the beneficial use line based on future collection of data. The BCT concurred that this would be acceptable for valid data.

One bedrock-zone well was installed during Phase I data gap investigation adjacent to Building 272 (RU-4). This well was originally planned to be a B-aquifer well, but based on cross-sections generated during fieldwork, the contamination is expected to be in the bedrock. Based on existing VOC concentrations in the bedrock-zone within RU-4 and the complex bedrock lithology at the area, the Navy is proposing an additional bedrock-zone well to be screened within a different bedrock unit to evaluate potential contaminant migration within the localized bedrock-zone. In addition, the Navy is also proposing to install one additional B-aquifer well during Phase II in Building 253 near a former spray booth.

The BCT recommend using ribbon samplers in this area to detect non-aqueous phase liquids (NAPL) or oily phase material. The BCT clarified this is only good for open bore holes and also might not work in bore holes that cave in. The BCT is concerned about NAPL contamination and potential NAPL data gaps. The BCT requested how the Navy is determining the screened interval for their wells. The Navy will look at the NAPL issue and provide recommendations to the BCT.

EVS DISCUSSION

The Navy presented the EVS system. The Navy proposed submitting Phase II data using EVS, which will be used for Parcel C volatile organic compound plume interpretation and visualization. In addition, hard copies of typical data will be submitted, as requested by the BCT.

ACTION ITEMS

A summary of action items identified at the meeting is presented below. These action items will be added to the comprehensive action item list included in the monthly BCT meeting minutes.

Action	**Responsible Party**	**Date Due**	**Notes**
Parcel C and D. The Navy will double-check TDS data used in the beneficial use letter.	July Crosby (Navy)	8-Jan-01	Will be addressed in the FSP/QAPP
Parcel C and D. The Navy will look at the NAPL issue and provide recommendations to the BCT.	July Crosby (Navy)	8-Jan-01	Will be addressed in the FSP/QAPP

ATTACHMENT A
LIST OF ATTENDEES

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RATIONALE FOR PARCEL E WELL SAMPLING, PHASE II GDGI

Samples will be collected at Parcel E groundwater wells during the Phase II groundwater data gaps investigation (GDGI). Table 4-7 of the field sampling plan (FSP) addendum lists the wells to be sampled, the analytes sampled for, and the sampling rationale. A review of the data of previously sampled wells at Parcel E was performed to determine which wells should be resampled, and for which analytes. Wells were selected for resampling based on the criteria set forth in the data quality objective (DQO) IV in the Phase I GDGI quality assurance project plan (QAPP) and additional criteria established during the November 7, 2000 groundwater meeting with the Base Realignment and Closure (BRAC) Cleanup Team (BCT). The following sections summarize the rationale for the well selection process.

Sampling Based on Previous Exceedances

DQO IV (Step 7) of the Phase I GDGI was used as a guideline to select A-aquifer and bedrock water-bearing wells for resampling. Since all of the existing B-aquifer wells are proposed for resampling, it is not necessary to use the criteria in DQO IV to select which B-aquifer wells to resample. Step 7 of DQO IV was used as the guideline for selecting wells for resampling.

Specific analytes were selected based on the following criteria

- Detection of analytes above the Hunters Point groundwater ambient level (HGAL) and the lower of the California or federal Maximum Contaminant Limits (MCL) or the National ambient water quality criteria (NAWQC)

- Detections of total petroleum hydrocarbons (TPH) above screening criteria (100 micrograms per liter [μg/L] of TPH as gasoline, 1000 μg/L of TPH as diesel or motor oil)

- Detection of gross alpha or gross beta radioactivity above the lower of California or federal MCL

In limited instances, as agreed in the November 7, 2000 BCT meeting, where two or more rounds of sampling indicated previously detected contaminants were no longer above the listed standards (MCLs, NAWQCs, HGALs), sampling will not be performed. For example, bis (2-ethylhexyl) phthalate was once detected in IR15MW09F, but was not detected in two subsequent rounds. This well will not be sampled again for bis (2-ethylhexyl) phthalate.

Additional Criteria

In addition to the wells selected per DQO IV, the Navy plans to sample selected wells as listed in Table 4-7 to evaluate the following conditions:

- Monitored Natural Attenuation (MNA) parameters at wells where volatile organic compound (VOC) and/or TPH analyses are being conducted

- Total dissolved solids (TDS) at every selected well to evaluate beneficial use.

- Migration or presence of gross alpha and gross beta radioactivity in wells near historic disposal areas (especially northwestern installation restoration [IR] site 02) and in wells near the former locations of Naval Radiological Defense Laboratory (NRDL) facilities

- Presence of radium 226 and 228 where gross alpha and gross beta radioactivity exceeded MCLs
- Metals, pesticides and semi-volatile organic compounds (SVOC) at selected wells that had detection limits greater than MCLs or NAWQC

MNA parameters include iron (II), iron (III), manganese (II), nitrate, nitrite, sulfate, dissolved oxygen, chloride, total alkalinity, hydroxide alkalinity, carbonate, bicarbonate, calcium, magnesium, sodium, and potassium.

The Navy evaluated previously collected groundwater data for cases in which detection limits exceeded screening criteria. The data review found instances of detection limits above criteria for metals, pesticides and SVOCs.

For metals, there were eleven instances in which the detection limits were above the screening criteria. The metals were copper (3 instances), nickel (7 instances) and mercury (1 instance). Nine of these wells were planned for sampling, and the appropriate metals were added to the list of analytes. Of the two remaining wells, IR02MW149A was added to the list of wells to be sampled to test for copper, as it is less than 100 feet from the shoreline but PA36MW01A was not added for nickel sampling. PA36MW01A was not added because it is distant from the shoreline, the well had no detections of nickel, and nickel was not an analyte of concern in the surrounding area.

Detection limits of pesticides in previous sampling events exceeded criteria for some samples of 4,4 DDT, 2,4,5-trichlorophenol, dieldrin, heptachlor, endrin, endosulfan sulfate and toxaphene. Two of these pesticides, 2,4,5-trichlorophenol and toxaphene, have not been detected in any soil or groundwater samples at Hunters Point Shipyard. Because there is no history of 2,4,5-trichlorophenol or toxaphene at Parcel E, these analytes were not added for resampling at any wells. The other pesticides were occasionally detected in both soil and groundwater. The detection limits exceeded screening criteria in all Parcel E wells on at least one occasion. To address this data gap, the Navy developed a representative selection of wells. Sixteen wells (greater than 10 percent of the total wells) were chosen to meet the following criteria:

- Spatial coverage of Parcel E
- Wells in areas where pesticides were detected in soil samples.

Detection limits of SVOCs exceeded screening criteria in nearly all Parcel E wells. Samples analyzed for pentachlorophenol and phenanthrene, in particular, had detection limits above criteria in nearly all Parcel E wells. The same approach was used for SVOCs as for pesticides. Sixteen wells were selected for both spatial coverage and for assessment of groundwater in areas where pentachlorophenol and phenanthrene had been detected in soil (note: these 16 wells are not the exact set of wells with detection limit issues for pesticides).

TABLE 1
SUMMARY OF RESULTS OFGROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL E GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Station	Analyte Name	CAS Number	Maximum Detection	Criteria Exceeded[g]	HGAL[a]	NAWQC[b]	EPA Primary MCL (mg/L)[c]	California Primary MCL (mg/L)[b]	EPA Region 9 Tap Water PRG (mg/L)[d]	Number of Sampling Events that Exceed MCLs	Two or More Subsequent Sampling Events below Criteria[e]	Number of Sampling Events
IR01	IR01MW03A	1,4-Dichlorobenzene	106467	7.00	MCL				5.00	0.50	**3**	-	3
IR01	IR01MW03A	Aluminum	7429905	1,870.00	MCL				1,000.00	36,498.67	1	-	3
IR01	IR01MW03A	Aroclor-1260	11096825	1.00	MCL			0.50		0.03	1	-	3
IR01	IR01MW03A	Benzene	71432	2.00	MCL			5.00	1.00	0.41	1	-	3
IR01	IR01MW03A	Copper	7440508	40.90	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR01	IR01MW03A	Lead	7439921	24.40	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR01	IR01MW03A	Zinc	7440666	152.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR01	IR01MW05A	Aluminum	7429905	15,100.00	MCL				1,000.00	36,498.67	1	-	4
IR01	IR01MW05A	Antimony	7440360	286.00	MCL	43.26	500.00	6.00	6.00	14.60	**2**	yes	4
IR01	IR01MW05A	Aroclor-1242	53469219	38.00	MCL			0.50		0.03	**2**	-	3
IR01	IR01MW05A	Aroclor-1260	11096825	36.00	MCL			0.50		0.03	**3**	-	3
IR01	IR01MW05A	Arsenic	7440382	41.30	NAWQC	27.34	36.00	50.00	50.00	0.04	1	yes	4
IR01	IR01MW05A	Benzene	71432	2.00	MCL			5.00	1.00	0.41	1	-	3
IR01	IR01MW05A	Cadmium	7440439	20.20	0.00	5.08	9.30	5.00	5.00	18.25	1	yes	4
IR01	IR01MW05A	Chromium	7440473	647.00	MCL	15.66			50.00		1	yes	4
IR01	IR01MW05A	Copper	7440508	1,240.00	NAWQC	28.04	2.40		1,300.00	1,355.71	**2**	yes	4
IR01	IR01MW05A	Lead	7439921	1,960.00	NAWQC	14.44	8.10	15.00	15.00		1	yes	4
IR01	IR01MW05A	Mercury	7439976	4.60	NAWQC	0.60	0.03		2.00	11.00	1	yes	4
IR01	IR01MW05A	Nickel	7440020	780.00	NAWQC	96.48	8.20		100.00	730.00	**4**	-	4
IR01	IR01MW05A	Silver	7440224	8.50	NAWQC	7.43	0.92			182.50	1	yes	4
IR01	IR01MW05A	Zinc	7440666	3,920.00	NAWQC	75.68	81.00			10,949.88	**3**	-	4
IR01	IR01MW16A	Aluminum	7429905	2,080.00	MCL				1,000.00	36,498.67	1	-	3
IR01	IR01MW16A	Aroclor-1242	53469219	52.00	MCL			0.50		0.03	**2**	-	3
IR01	IR01MW16A	Benzene	71432	4.29	MCL			5.00	1.00	0.41	**3**	-	3
IR01	IR01MW16A	Copper	7440508	45.50	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR01	IR01MW16A	Lead	7439921	358.00	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR01	IR01MW16A	Zinc	7440666	255.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR01	IR01MW18A	Aluminum	7429905	15,200.00	MCL				1,000.00	36,498.67	1	-	4
IR01	IR01MW18A	Aroclor-1242	53469219	8.90	MCL			0.50		0.03	1	-	4
IR01	IR01MW18A	Benzene	71432	7.01	MCL			5.00	1.00	0.41	**3**	-	4
IR01	IR01MW18A	Chromium	7440473	299.00	MCL	15.66			50.00		1	-	4
IR01	IR01MW18A	Copper	7440508	579.00	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	4
IR01	IR01MW18A	Lead	7439921	666.00	NAWQC	14.44	8.10	15.00	15.00		1	-	4
IR01	IR01MW18A	Mercury	7439976	2.20	NAWQC	0.60	0.03		2.00	11.00	1	-	4
IR01	IR01MW18A	Nickel	7440020	762.00	NAWQC	96.48	8.20		100.00	730.00	**3**	-	4
IR01	IR01MW18A	Phenanthrene	85018	22.36	NAWQC		4.60			6.20	**3**	-	4
IR01	IR01MW18A	Zinc	7440666	1,060.00	NAWQC	75.68	81.00			10,949.88	1	-	4

TABLE 1
SUMMARY OF RESULTS OFGROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL E GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Station	Analyte Name	CAS Number	Maximum Detection	Criteria Exceeded[g]	HGAL[a]	NAWQC[b]	EPA Primary MCL (mg/L)[c]	California Primary MCL (mg/L)[b]	EPA Region 9 Tap Water PRG (mg/L)[d]	Number of Sampling Events that Exceed MCLs	Two or More Subsequent Sampling Events below Criteria[e]	Number of Sampling Events
IR01	IR01MW31A	Aluminum	7429905	2,720.00	MCL				1,000.00	36,498.67	1	-	3
IR01	IR01MW31A	Aroclor-1242	53469219	4.60	MCL			0.50		0.03	1	-	2
IR01	IR01MW31A	Aroclor-1260	11096825	2.40	MCL			0.50		0.03	1	-	2
IR01	IR01MW31A	Benzene	71432	3.00	MCL			5.00	1.00	0.41	**2**	-	3
IR01	IR01MW31A	Lead	7439921	27.10	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR01	IR01MW31A	Tetrachloroethene	127184	6.00	MCL				5.00	1.08	1	-	3
IR01	IR01MW366A	Cadmium	7440439	6.30	MCL	5.08	9.30	5.00	5.00	18.25	1	-	3
IR01	IR01MW366A	Copper	7440508	607.00	NAWQC	28.04	2.40		1,300.00	1,355.71	**2**	-	3
IR01	IR01MW366A	Mercury	7439976	5.30	NAWQC	0.60	0.03		2.00	11.00	**2**	-	3
IR01	IR01MW366A	Nickel	7440020	101.00	NAWQC	96.48	8.20		100.00	730.00	**3**	-	3
IR01	IR01MW366A	Pentachlorophenol	87865	6.00	MCL		7.90	1.00	1.00	0.56	**2**	-	3
IR01	IR01MW366A	Zinc	7440666	682.00	NAWQC	75.68	81.00			10,949.88	**2**	-	3
IR01	IR01MW367A	Benzene	71432	3.00	MCL			5.00	1.00	0.41	**2**	-	3
IR01	IR01MW367A	Endosulfan sulfate	1031078	0.04	NAWQC		0.01			219.00	1	-	3
IR01	IR01MW367A	Zinc	7440666	111.00	NAWQC	75.68	81.00			10,949.88	1	yes	3
IR01	IR01MW38A	Benzene	71432	44.00	MCL			5.00	1.00	0.41	1	-	3
IR01	IR01MW400A	Aroclor-1242	53469219	3.10	MCL			0.50		0.03	**3**	-	3
IR01	IR01MW400A	Aroclor-1248	12672296	2.10	MCL			0.50		0.03	1	yes	3
IR01	IR01MW42A	Lead	7439921	100.00	NAWQC	14.44	8.10	15.00	15.00		1	yes	3
IR01	IR01MW43A	1,1-Dichloroethane	75343	16.00	MCL				5.00	811.11	**2**	-	4
IR01	IR01MW43A	1,4-Dichlorobenzene	106467	16.00	MCL				5.00	0.50	**4**	-	4
IR01	IR01MW43A	Antimony	7440360	49.10	MCL	43.26	500.00	6.00	6.00	14.60	**2**	-	4
IR01	IR01MW43A	Aroclor-1260	11096825	37.00	MCL			0.50		0.03	**3**	-	4
IR01	IR01MW43A	Benzene	71432	14.00	MCL			5.00	1.00	0.41	**4**	-	4
IR01	IR01MW43A	Endrin	72208	0.13	NAWQC		0.00	2.00	2.00	10.95	1	-	4
IR01	IR01MW44A	Aroclor-1260	11096825	34.00	MCL			0.50		0.03	**4**	-	4
IR01	IR01MW44A	Endrin	72208	0.13	NAWQC		0.00	2.00	2.00	10.95	1	-	4
IR01	IR01MW44A	Heptachlor	76448	0.01	NAWQC		0.00	0.40	0.01	0.01	1	-	4
IR01	IR01MW44A	Zinc	7440666	235.00	NAWQC	75.68	81.00			10,949.88	1	yes	4
IR01	IR01MW48A	Aluminum	7429905	4,190.00	MCL				1,000.00	36,498.67	1	-	3
IR01	IR01MW48A	Barium	7440393	1,880.00	MCL	504.20		2,000.00	1,000.00	2,554.99	**3**	-	3
IR01	IR01MW48A	Benzene	71432	4.00	MCL			5.00	1.00	0.41	**3**	-	3
IR01	IR01MW48A	Chromium	7440473	56.20	MCL	15.66			50.00		1	-	3
IR01	IR01MW48A	Copper	7440508	52.40	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR01	IR01MW48A	Lead	7439921	61.20	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR01	IR01MW48A	Zinc	7440666	164.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR01	IR01MW58A	Barium	7440393	2,610.00	MCL	504.20		2,000.00	1,000.00	2,554.99	**3**	-	3

TABLE 1
SUMMARY OF RESULTS OFGROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL E GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(PAGE 3 OF 11)

IR Site	Station	Analyte Name	CAS Number	Maximum Detection	Criteria Exceeded[g]	HGAL[a]	NAWQC[b]	EPA Primary MCL (mg/L)[c]	California Primary MCL (mg/L)[b]	EPA Region 9 Tap Water PRG (mg/L)[d]	Number of Sampling Events that Exceed MCLs	Two or More Subsequent Sampling Events below Criteria[e]	Number of Sampling Events
IR01	IR01MW58A	Benzene	71432	6.00	MCL			5.00	1.00	0.41	**3**	-	3
IR01	IR01MW62A	Aluminum	7429905	53,300.00	MCL				1,000.00	36,498.67	1	-	3
IR01	IR01MW62A	Antimony	7440360	46.90	MCL	43.26	500.00	6.00	6.00	14.60	**2**	-	3
IR01	IR01MW62A	Arsenic	7440382	69.60	NAWQC	27.34	36.00	50.00	50.00	0.04	1	-	3
IR01	IR01MW62A	Barium	7440393	7,480.00	MCL	504.20		2,000.00	1,000.00	2,554.99	**3**	-	3
IR01	IR01MW62A	Benzo(a)pyrene	50328	2.00	MCL			0.20	0.20	0.01	1	-	3
IR01	IR01MW62A	Cadmium	7440439	11.10	0.00	5.08	9.30	5.00	5.00	18.25	1	-	3
IR01	IR01MW62A	Chromium	7440473	459.00	MCL	15.66			50.00		1	-	3
IR01	IR01MW62A	Copper	7440508	940.00	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR01	IR01MW62A	Lead	7439921	3,740.00	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR01	IR01MW62A	Mercury	7439976	4.40	NAWQC	0.60	0.03		2.00	11.00	1	-	3
IR01	IR01MW62A	Nickel	7440020	740.00	NAWQC	96.48	8.20		100.00	730.00	**2**	-	3
IR01	IR01MW62A	Phenanthrene	85018	11.00	NAWQC		4.60			6.20	**2**	-	3
IR01	IR01MW62A	Zinc	7440666	5,050.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR01	IR01MW63A	Barium	7440393	1,080.00	MCL	504.20		2,000.00	1,000.00	2,554.99	1	-	3
IR01	IR01MWI-2	Aluminum	7429905	183,000.00	MCL				1,000.00	36,498.67	1	-	3
IR01	IR01MWI-2	Arsenic	7440382	77.80	NAWQC	27.34	36.00	50.00	50.00	0.04	1	-	3
IR01	IR01MWI-2	Barium	7440393	1,500.00	MCL	504.20		2,000.00	1,000.00	2,554.99	1	-	3
IR01	IR01MWI-2	Beryllium	7440417	5.10	MCL	1.40		4.00	4.00	73.00	1	-	3
IR01	IR01MWI-2	Chromium	7440473	2,750.00	MCL	15.66			50.00		1	-	3
IR01	IR01MWI-2	Copper	7440508	399.00	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR01	IR01MWI-2	Lead	7439921	128.00	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR01	IR01MWI-2	Mercury	7439976	1.10	NAWQC	0.60	0.03		2.00	11.00	1	-	3
IR01	IR01MWI-2	Nickel	7440020	6,260.00	NAWQC	96.48	8.20		100.00	730.00	**3**	-	3
IR01	IR01MWI-2	Zinc	7440666	632.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR01	IR01MWI-3	1,4-Dichlorobenzene	106467	7.00	MCL				5.00	0.50	**2**	-	4
IR01	IR01MWI-3	Aroclor-1260	11096825	54.00	MCL			0.50		0.03	**4**	-	4
IR01	IR01MWI-3	Benzene	71432	9.00	MCL			5.00	1.00	0.41	**4**	-	4
IR01	IR01MWI-3	Benzo(a)pyrene	50328	3.00	MCL			0.20	0.20	0.01	**2**	-	4
IR01	IR01MWI-3	Nickel	7440020	315.00	NAWQC	96.48	8.20		100.00	730.00	**4**	-	4
IR01	IR01MWI-3	Zinc	7440666	323.00	NAWQC	75.68	81.00			10,949.88	1	-	4
IR01	IR01MWI-5	1,4-Dichlorobenzene	106467	10.00	MCL				5.00	0.50	**2**	-	3
IR01	IR01MWI-5	Aluminum	7429905	24,700.00	MCL				1,000.00	36,498.67	1	-	3
IR01	IR01MWI-5	Antimony	7440360	78.70	MCL	43.26	500.00	6.00	6.00	14.60	1	-	3
IR01	IR01MWI-5	Aroclor-1242	53469219	17.00	MCL			0.50		0.03	1	-	3
IR01	IR01MWI-5	Aroclor-1260	11096825	16.00	MCL			0.50		0.03	**2**	-	3
IR01	IR01MWI-5	Barium	7440393	1,120.00	MCL	504.20		2,000.00	1,000.00	2,554.99	1	-	3

TABLE 1
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PARCEL E GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Station	Analyte Name	CAS Number	Maximum Detection	Criteria Exceeded[g]	HGAL[a]	NAWQC[b]	EPA Primary MCL (mg/L)[c]	California Primary MCL (mg/L)[b]	EPA Region 9 Tap Water PRG (mg/L)[d]	Number of Sampling Events that Exceed MCLs	Two or More Subsequent Sampling Events below Criteria[e]	Number of Sampling Events
IR01	IR01MWI-5	Benzene	71432	5.00	MCL			5.00	1.00	0.41	**2**	-	3
IR01	IR01MWI-5	Chromium	7440473	370.00	MCL	15.66			50.00		1	-	3
IR01	IR01MWI-5	Copper	7440508	1,780.00	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR01	IR01MWI-5	Heptachlor	76448	0.46	NAWQC		0.00	0.40	0.01	0.01	1	-	3
IR01	IR01MWI-5	Lead	7439921	1,430.00	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR01	IR01MWI-5	Mercury	7439976	6.50	NAWQC	0.60	0.03		2.00	11.00	1	-	3
IR01	IR01MWI-5	Nickel	7440020	476.00	NAWQC	96.48	8.20		100.00	730.00	**3**	-	3
IR01	IR01MWI-5	Phenanthrene	85018	39.00	NAWQC		4.60			6.20	**3**	-	3
IR01	IR01MWI-5	Zinc	7440666	3,540.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR01	IR01MWI-9	Aluminum	7429905	91,200.00	MCL				1,000.00	36,498.67	1	-	3
IR01	IR01MWI-9	Antimony	7440360	62.90	MCL	43.26	500.00	6.00	6.00	14.60	1	-	3
IR01	IR01MWI-9	Aroclor-1242	53469219	8.70	MCL			0.50		0.03	1	-	3
IR01	IR01MWI-9	Aroclor-1260	11096825	4.50	MCL			0.50		0.03	**2**	-	3
IR01	IR01MWI-9	Arsenic	7440382	61.60	NAWQC	27.34	36.00	50.00	50.00	0.04	1	-	3
IR01	IR01MWI-9	Barium	7440393	1,720.00	MCL	504.20		2,000.00	1,000.00	2,554.99	1	-	3
IR01	IR01MWI-9	Benzo(a)pyrene	50328	2.00	MCL			0.20	0.20	0.01	1	-	3
IR01	IR01MWI-9	Cadmium	7440439	7.00	MCL	5.08	9.30	5.00	5.00	18.25	1	-	3
IR01	IR01MWI-9	Chromium	7440473	828.00	MCL	15.66			50.00		1	-	3
IR01	IR01MWI-9	Copper	7440508	794.00	NAWQC	28.04	2.40		1,300.00	1,355.71	**2**	-	3
IR01	IR01MWI-9	Lead	7439921	6,520.00	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR01	IR01MWI-9	Mercury	7439976	10.00	NAWQC	0.60	0.03		2.00	11.00	1	-	3
IR01	IR01MWI-9	Nickel	7440020	1,080.00	NAWQC	96.48	8.20		100.00	730.00	1	-	3
IR01	IR01MWI-9	Silver	7440224	8.60	NAWQC	7.43	0.92			182.50	1	-	3
IR01	IR01MWI-9	Zinc	7440666	2,560.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR01	IR01MW02B	Aluminum	7429905	3,630.00	MCL				1,000.00	36,498.67	1	-	3
IR01	IR01MW02B	Chromium	7440473	80.00	MCL	15.66			50.00		**3**	-	3
IR01	IR01MW02B	Chromium VI	18540299	130.00	NAWQC		50.00			109.50	1	-	3
IR01	IR01MW02B	Phenanthrene	85018	9.00	NAWQC		4.60			6.20	1	yes	3
IR01	IR01MW17B	Aluminum	7429905	4,040.00	MCL				1,000.00	36,498.67	1	-	3
IR01	IR01MW17B	Antimony	7440360	96.30	MCL	43.26	500.00	6.00	6.00	14.60	1	-	3
IR01	IR01MW17B	Bis(2-ethylhexyl)phthalate	117817	160.00	MCL		360.00		4.00	4.80	1	-	3
IR01	IR01MW17B	Cadmium	7440439	7.60	MCL	5.08	9.30	5.00	5.00	18.25	1	-	3
IR01	IR01MW47B	Carbon Tetrachloride	56235	3.00	MCL			5.00	0.50	0.17	1	-	3
IR01	IR01MW53B	Cadmium	7440439	8.00	MCL	5.08	9.30	5.00	5.00	18.25	1	-	3
IR02	IR02MW101A1	Aluminum	7429905	4,450.00	MCL				1,000.00	36,498.67	1	-	3
IR02	IR02MW101A1	Chromium	7440473	69.00	MCL	15.66			50.00		1	-	3
IR02	IR02MW101A1	Nickel	7440020	202.00	NAWQC	96.48	8.20		100.00	730.00	**2**	-	3

TABLE 1
SUMMARY OF RESULTS OFGROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL E GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Station	Analyte Name	CAS Number	Maximum Detection	Criteria Exceeded[g]	HGAL[a]	NAWQC[b]	EPA Primary MCL (mg/L)[c]	California Primary MCL (mg/L)[b]	EPA Region 9 Tap Water PRG (mg/L)[d]	Number of Sampling Events that Exceed MCLs	Two or More Subsequent Sampling Events below Criteria[e]	Number of Sampling Events
IR02	IR02MW101A1	Pentachlorophenol	87865	3.00	MCL		7.90	1.00	1.00	0.56	1	-	3
IR02	IR02MW101A2	Barium	7440393	1,950.00	MCL	504.20		2,000.00	1,000.00	2,554.99	**3**	-	3
IR02	IR02MW101A2	Cadmium	7440439	14.70	0.00	5.08	9.30	5.00	5.00	18.25	1	-	3
IR02	IR02MW114A1	Cadmium	7440439	15.80	0.00	5.08	9.30	5.00	5.00	18.25	1	-	3
IR02	IR02MW114A2	Aluminum	7429905	16,200.00	MCL				1,000.00	36,498.67	1	-	3
IR02	IR02MW114A2	Cadmium	7440439	8.10	MCL	5.08	9.30	5.00	5.00	18.25	1	-	3
IR02	IR02MW114A2	Chromium	7440473	148.00	MCL	15.66			50.00		1	-	3
IR02	IR02MW114A2	Copper	7440508	32.90	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR02	IR02MW114A2	Nickel	7440020	267.00	NAWQC	96.48	8.20		100.00	730.00	1	-	3
IR02	IR02MW114A3	Barium	7440393	1,120.00	MCL	504.20		2,000.00	1,000.00	2,554.99	**2**	-	3
IR02	IR02MW114A3	Cadmium	7440439	37.90	0.00	5.08	9.30	5.00	5.00	18.25	**2**	-	3
IR02	IR02MW126A	Aroclor-1260	11096825	4.10	MCL			0.50		0.03	**3**	-	3
IR02	IR02MW126A	Barium	7440393	1,020.00	MCL	504.20		2,000.00	1,000.00	2,554.99	1	-	3
IR02	IR02MW126A	Copper	7440508	161.00	NAWQC	28.04	2.40		1,300.00	1,355.71	**2**	-	3
IR02	IR02MW126A	Lead	7439921	26.70	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR02	IR02MW126A	Zinc	7440666	125.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR02	IR02MW141A	Aluminum	7429905	22,600.00	MCL				1,000.00	36,498.67	1	-	3
IR02	IR02MW141A	Antimony	7440360	771.00	0.00	43.26	500.00	6.00	6.00	14.60	**2**	-	3
IR02	IR02MW141A	Aroclor-1242	53469219	2.30	MCL			0.50		0.03	1	-	3
IR02	IR02MW141A	Aroclor-1260	11096825	5.10	MCL			0.50		0.03	**3**	-	3
IR02	IR02MW141A	Barium	7440393	1,270.00	MCL	504.20		2,000.00	1,000.00	2,554.99	1	-	3
IR02	IR02MW141A	Cadmium	7440439	113.00	0.00	5.08	9.30	5.00	5.00	18.25	1	-	3
IR02	IR02MW141A	Chromium	7440473	517.00	MCL	15.66			50.00		1	-	3
IR02	IR02MW141A	Copper	7440508	19,800.00	NAWQC	28.04	2.40		1,300.00	1,355.71	**2**	-	3
IR02	IR02MW141A	Lead	7439921	10,200.00	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR02	IR02MW141A	Mercury	7439976	54.00	NAWQC	0.60	0.03		2.00	11.00	1	-	3
IR02	IR02MW141A	Nickel	7440020	1,450.00	NAWQC	96.48	8.20		100.00	730.00	**3**	-	3
IR02	IR02MW141A	Silver	7440224	68.90	NAWQC	7.43	0.92			182.50	1	-	3
IR02	IR02MW141A	Zinc	7440666	31,100.00	NAWQC	75.68	81.00			10,949.88	**3**	-	3
IR02	IR02MW146A	Aroclor-1260	11096825	8.70	MCL			0.50		0.03	1	yes	3
IR02	IR02MW146A	Benzene	71432	3.00	MCL			5.00	1.00	0.41	**3**	-	3
IR02	IR02MW147A	Pentachlorophenol	87865	2.00	MCL		7.90	1.00	1.00	0.56	1	-	1
IR02	IR02MW173A	Arsenic	7440382	75.70	NAWQC	27.34	36.00	50.00	50.00	0.04	**3**	-	3
IR02	IR02MW173A	Barium	7440393	4,250.00	MCL	504.20		2,000.00	1,000.00	2,554.99	**3**	-	3
IR02	IR02MW173A	Benzene	71432	2.00	MCL			5.00	1.00	0.41	1	-	3
IR02	IR02MW173A	Phenanthrene	85018	12.00	NAWQC		4.60			6.20	1	yes	3
IR02	IR02MW175A	1,2-Dichloroethane	107062	1.00	MCL			5.00	0.50	0.12	1	-	3

TABLE 1
SUMMARY OF RESULTS OFGROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL E GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Station	Analyte Name	CAS Number	Maximum Detection	Criteria Exceeded[g]	HGAL[a]	NAWQC[b]	EPA Primary MCL (mg/L)[c]	California Primary MCL (mg/L)[b]	EPA Region 9 Tap Water PRG (mg/L)[d]	Number of Sampling Events that Exceed MCLs	Two or More Subsequent Sampling Events below Criteria[e]	Number of Sampling Events
IR02	IR02MW175A	Aluminum	7429905	1,710.00	MCL				1,000.00	36,498.67	1	-	3
IR02	IR02MW175A	Tetrachloroethene	127184	6.00	MCL				5.00	1.08	1	-	3
IR02	IR02MW179A	Cadmium	7440439	8.40	MCL	5.08	9.30	5.00	5.00	18.25	1	-	3
IR02	IR02MW183A	Pentachlorophenol	87865	33.00	0.00		7.90	1.00	1.00	0.56	1	yes	3
IR02	IR02MW298A	Aluminum	7429905	7,510.00	MCL				1,000.00	36,498.67	1	yes	3
IR02	IR02MW298A	Chromium	7440473	70.60	MCL	15.66			50.00		1	yes	3
IR02	IR02MW298A	Nickel	7440020	200.00	NAWQC	96.48	8.20		100.00	730.00	1	yes	3
IR02	IR02MW299A	1,2-Dichloroethane	107062	1.00	MCL			5.00	0.50	0.12	1	-	3
IR02	IR02MW300A	Copper	7440508	45.80	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR02	IR02MW300A	Zinc	7440666	174.00	NAWQC	75.68	81.00			10,949.88	**2**	-	3
IR02	IR02MW372A	Benzene	71432	5.00	MCL			5.00	1.00	0.41	**3**	-	3
IR02	IR02MW372A	Dieldrin	60571	0.34	NAWQC		0.00			0.00	**2**	-	3
IR02	IR02MW372A	Endosulfan sulfate	1031078	0.06	NAWQC		0.01			219.00	1	-	3
IR02	IR02MW372A	Endrin	72208	1.00	NAWQC		0.00	2.00	2.00	10.95	**2**	-	3
IR02	IR02MW372A	Heptachlor epoxide	1024573	0.21	MCL			0.20	0.01	0.01	**2**	-	3
IR02	IR02MW372A	Vinyl Chloride	75014	0.80	MCL			2.00	0.50	0.02	**3**	-	3
IR02	IR02MW373A	Antimony	7440360	145.00	MCL	43.26	500.00	6.00	6.00	14.60	**3**	-	3
IR02	IR02MW373A	Aroclor-1260	11096825	0.99	MCL			0.50		0.03	1	-	3
IR02	IR02MW373A	Cadmium	7440439	5.80	MCL	5.08	9.30	5.00	5.00	18.25	1	-	3
IR02	IR02MW373A	Copper	7440508	1,210.00	NAWQC	28.04	2.40		1,300.00	1,355.71	**3**	-	3
IR02	IR02MW373A	Lead	7439921	28.70	NAWQC	14.44	8.10	15.00	15.00		**2**	-	3
IR02	IR02MW373A	Nickel	7440020	554.00	NAWQC	96.48	8.20		100.00	730.00	**3**	-	3
IR02	IR02MW373A	Zinc	7440666	4,200.00	NAWQC	75.68	81.00			10,949.88	**2**	-	3
IR02	IR02MW89A	Aluminum	7429905	3,560.00	MCL				1,000.00	36,498.67	1	-	3
IR02	IR02MW89A	Nickel	7440020	105.00	NAWQC	96.48	8.20		100.00	730.00	1	-	3
IR02	IR02MW93A	Nickel	7440020	256.00	NAWQC	96.48	8.20		100.00	730.00	**2**	-	3
IR02	IR02MW97A	4,4'-DDT	50293	0.18	NAWQC		0.00			0.20	**2**	-	3
IR02	IR02MW97A	Cadmium	7440439	7.00	MCL	5.08	9.30	5.00	5.00	18.25	1	-	3
IR02	IR02MWB-1	Aluminum	7429905	29,800.00	MCL				1,000.00	36,498.67	1	-	3
IR02	IR02MWB-1	Arsenic	7440382	65.80	NAWQC	27.34	36.00	50.00	50.00	0.04	1	-	3
IR02	IR02MWB-1	Chromium	7440473	472.00	MCL	15.66			50.00		1	-	3
IR02	IR02MWB-1	Copper	7440508	60.40	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR02	IR02MWB-1	Nickel	7440020	1,470.00	NAWQC	96.48	8.20		100.00	730.00	**3**	-	3
IR02	IR02MWB-1	Zinc	7440666	99.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR02	IR02MWB-2	Aluminum	7429905	19,200.00	MCL				1,000.00	36,498.67	1	-	3
IR02	IR02MWB-2	Carbon Tetrachloride	56235	11.00	MCL			5.00	0.50	0.17	1	-	3
IR02	IR02MWB-2	Chromium	7440473	544.00	MCL	15.66			50.00		1	-	3

TABLE 1
SUMMARY OF RESULTS OFGROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL E GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Station	Analyte Name	CAS Number	Maximum Detection	Criteria Exceeded[g]	HGAL[a]	NAWQC[b]	EPA Primary MCL (mg/L)[c]	California Primary MCL (mg/L)[b]	EPA Region 9 Tap Water PRG (mg/L)[d]	Number of Sampling Events that Exceed MCLs	Two or More Subsequent Sampling Events below Criteria[e]	Number of Sampling Events
IR02	IR02MWB-2	Copper	7440508	105.00	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR02	IR02MWB-2	Lead	7439921	38.40	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR02	IR02MWB-2	Mercury	7439976	1.70	NAWQC	0.60	0.03		2.00	11.00	1	-	3
IR02	IR02MWB-2	Nickel	7440020	235.00	NAWQC	96.48	8.20		100.00	730.00	**3**	-	3
IR02	IR02MWB-2	Thallium	7440280	17.50	MCL	12.97		2.00	2.00		1	-	1
IR02	IR02MWB-2	Zinc	7440666	100.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR02	IR02MWB-3	Aluminum	7429905	8,510.00	MCL				1,000.00	36,498.67	1	-	3
IR02	IR02MWB-3	Antimony	7440360	556.00	0.00	43.26	500.00	6.00	6.00	14.60	**3**	-	3
IR02	IR02MWB-3	Benzo(a)pyrene	50328	2.00	MCL			0.20	0.20	0.01	1	-	3
IR02	IR02MWB-3	Cadmium	7440439	23.60	0.00	5.08	9.30	5.00	5.00	18.25	1	-	3
IR02	IR02MWB-3	Chromium	7440473	242.00	MCL	15.66			50.00		1	-	3
IR02	IR02MWB-3	Copper	7440508	3,900.00	NAWQC	28.04	2.40		1,300.00	1,355.71	**2**	-	3
IR02	IR02MWB-3	Lead	7439921	1,350.00	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR02	IR02MWB-3	Mercury	7439976	24.00	NAWQC	0.60	0.03		2.00	11.00	1	-	3
IR02	IR02MWB-3	Nickel	7440020	269.00	NAWQC	96.48	8.20		100.00	730.00	1	-	3
IR02	IR02MWB-3	Pentachlorophenol	87865	6.00	MCL		7.90	1.00	1.00	0.56	**2**	-	3
IR02	IR02MWB-3	Zinc	7440666	4,880.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR02	IR02MWB-5	Aroclor-1260	11096825	0.81	MCL			0.50		0.03	1	-	3
IR02	IR02MW372A	4,4'-DDT	50293	0.30	NAWQC		0.00			0.20	**2**	-	3
IR03	IR03MW218A1	Aroclor-1260	11096825	32.00	MCL			0.50		0.03	1	-	2
IR03	IR03MW218A1	Barium	7440393	4,830.00	MCL	504.20		2,000.00	1,000.00	2,554.99	1	-	2
IR03	IR03MW218A1	Lead	7439921	23.40	NAWQC	14.44	8.10	15.00	15.00		1	-	2
IR03	IR03MW218A1	Phenanthrene	85018	40.00	NAWQC		4.60			6.20	**2**	-	2
IR03	IR03MW218A2	Barium	7440393	19,400.00	MCL	504.20		2,000.00	1,000.00	2,554.99	**3**	-	3
IR03	IR03MW218A2	Benzene	71432	13.00	MCL			5.00	1.00	0.41	**3**	-	3
IR03	IR03MW218A2	Copper	7440508	68.80	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR03	IR03MW218A2	Lead	7439921	83.00	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR03	IR03MW218A2	Zinc	7440666	94.50	NAWQC	75.68	81.00			10,949.88	1	-	3
IR03	IR03MW218A3	Barium	7440393	1,580.00	MCL	504.20		2,000.00	1,000.00	2,554.99	**3**	-	3
IR03	IR03MW218A3	Benzene	71432	3.00	MCL			5.00	1.00	0.41	1	yes	3
IR03	IR03MW224A	Aluminum	7429905	20,200.00	MCL				1,000.00	36,498.67	1	-	3
IR03	IR03MW224A	Aroclor-1260	11096825	0.71	MCL			0.50		0.03	**2**	-	3
IR03	IR03MW224A	Chromium	7440473	63.60	MCL	15.66			50.00		1	-	3
IR03	IR03MW224A	Copper	7440508	34.50	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR03	IR03MW225A	1,2-Dichloroethane	107062	4.00	MCL			5.00	0.50	0.12	1	yes	3
IR03	IR03MW225A	1,4-Dichlorobenzene	106467	17.00	MCL				5.00	0.50	**3**	-	3
IR03	IR03MW225A	Aroclor-1260	11096825	3.80	MCL			0.50		0.03	**2**	-	3

TABLE 1
SUMMARY OF RESULTS OFGROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL E GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Station	Analyte Name	CAS Number	Maximum Detection	Criteria Exceeded[g]	HGAL[a]	NAWQC[b]	EPA Primary MCL (mg/L)[c]	California Primary MCL (mg/L)[b]	EPA Region 9 Tap Water PRG (mg/L)[d]	Number of Sampling Events that Exceed MCLs	Two or More Subsequent Sampling Events below Criteria[e]	Number of Sampling Events
IR03	IR03MW225A	Benzene	71432	3.00	MCL			5.00	1.00	0.41	**2**	-	3
IR03	IR03MW225A	Chlorobenzene	108907	150.00	MCL			100.00	70.00	106.07	**2**	-	3
IR03	IR03MW225A	Phenanthrene	85018	7.00	NAWQC		4.60			6.20	1	yes	3
IR03	IR03MW226A	1,2-Dichloroethane	107062	3.00	MCL			5.00	0.50	0.12	1	yes	3
IR03	IR03MW226A	Aluminum	7429905	4,900.00	MCL				1,000.00	36,498.67	1	-	3
IR03	IR03MW226A	Antimony	7440360	63.90	MCL	43.26	500.00	6.00	6.00	14.60	1	-	3
IR03	IR03MW226A	Aroclor-1260	11096825	12.00	MCL			0.50		0.03	**2**	-	3
IR03	IR03MW226A	Barium	7440393	7,070.00	MCL	504.20		2,000.00	1,000.00	2,554.99	1	-	3
IR03	IR03MW226A	Benzene	71432	4.00	MCL			5.00	1.00	0.41	**2**	-	3
IR03	IR03MW226A	Chromium	7440473	68.60	MCL	15.66			50.00		1	-	3
IR03	IR03MW226A	Copper	7440508	824.00	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR03	IR03MW226A	Lead	7439921	613.00	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR03	IR03MW226A	Mercury	7439976	0.80	NAWQC	0.60	0.03		2.00	11.00	1	-	3
IR03	IR03MW226A	Nickel	7440020	146.00	NAWQC	96.48	8.20		100.00	730.00	**2**	-	3
IR03	IR03MW226A	Phenanthrene	85018	15.00	NAWQC		4.60			6.20	**3**	-	3
IR03	IR03MW226A	Zinc	7440666	1,180.00	NAWQC	75.68	81.00			10,949.88	**2**	-	3
IR03	IR03MW342A	Aluminum	7429905	14,000.00	MCL				1,000.00	36,498.67	**2**	-	4
IR03	IR03MW342A	Barium	7440393	2,007.45	MCL	504.20		2,000.00	1,000.00	2,554.99	**4**	-	4
IR03	IR03MW342A	Benzene	71432	5.00	MCL			5.00	1.00	0.41	1	-	3
IR03	IR03MW342A	Chromium	7440473	165.00	MCL	15.66			50.00		1	yes	4
IR03	IR03MW342A	Copper	7440508	422.00	NAWQC	28.04	2.40		1,300.00	1,355.71	**2**	yes	4
IR03	IR03MW342A	Lead	7439921	324.00	NAWQC	14.44	8.10	15.00	15.00		**2**	yes	4
IR03	IR03MW342A	Mercury	7439976	2.00	NAWQC	0.60	0.03		2.00	11.00	1	yes	4
IR03	IR03MW342A	Nickel	7440020	332.00	NAWQC	96.48	8.20		100.00	730.00	**2**	yes	4
IR03	IR03MW342A	Pentachlorophenol	87865	6.00	MCL		7.90	1.00	1.00	0.56	1	yes	3
IR03	IR03MW342A	Zinc	7440666	866.00	NAWQC	75.68	81.00			10,949.88	**2**	yes	4
IR03	IR03MW369A	Benzene	71432	2.00	MCL			5.00	1.00	0.41	**3**	-	3
IR03	IR03MW369A	Phenanthrene	85018	7.00	NAWQC		4.60			6.20	1	-	3
IR03	IR03MW370A	Barium	7440393	2,110.00	MCL	504.20		2,000.00	1,000.00	2,554.99	**3**	-	3
IR03	IR03MW370A	Benzene	71432	2.00	MCL			5.00	1.00	0.41	**2**	-	3
IR03	IR03MW370A	Phenanthrene	85018	8.00	NAWQC		4.60			6.20	1	-	3
IR03	IR03MW371A	Aroclor-1260	11096825	1.00	MCL			0.50		0.03	**2**	-	3
IR03	IR03MWO-1	1,4-Dichlorobenzene	106467	84.00	MCL				5.00	0.50	**3**	-	3
IR03	IR03MWO-1	Aluminum	7429905	37,000.00	MCL				1,000.00	36,498.67	1	-	3
IR03	IR03MWO-1	Aroclor-1260	11096825	290.00						0.03	**2**	-	3
IR03	IR03MWO-1	Arsenic	7440382	1,180.00	NAWQC	27.34	36.00	50.00	50.00	0.04	**3**	-	3
IR03	IR03MWO-1	Barium	7440393	11,100.00	MCL	504.20		2,000.00	1,000.00	2,554.99	**2**	-	3

TABLE 1
SUMMARY OF RESULTS OFGROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL E GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Station	Analyte Name	CAS Number	Maximum Detection	Criteria Exceeded[g]	HGAL[a]	NAWQC[b]	EPA Primary MCL (μg/L)[c]	California Primary MCL (μg/L)[b]	EPA Region 9 Tap Water PRG (μg/L)[d]	Number of Sampling Events that Exceed MCLs	Two or More Subsequent Sampling Events below Criteria[e]	Number of Sampling Events
IR03	IR03MWO-1	Benzene	71432	9.00	MCL			5.00	1.00	0.41	**3**	-	3
IR03	IR03MWO-1	Chromium	7440473	567.00	MCL	15.66			50.00		1	-	3
IR03	IR03MWO-1	Copper	7440508	3,240.00	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR03	IR03MWO-1	Lead	7439921	65.00	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR03	IR03MWO-1	Mercury	7439976	1.20	NAWQC	0.60	0.03		2.00	11.00	1	-	3
IR03	IR03MWO-1	Nickel	7440020	1,140.00	NAWQC	96.48	8.20		100.00	730.00	**2**	-	3
IR03	IR03MWO-1	Phenanthrene	85018	69.00	NAWQC		4.60			6.20	**2**	-	3
IR03	IR03MWO-1	Trichloroethene	79016	15.00	MCL				5.00	1.64	1	-	3
IR03	IR03MWO-1	Zinc	7440666	2,400.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR03	IR03MW228B	Cadmium	7440439	5.60	MCL	5.08	9.30	5.00	5.00	18.25	1	-	3
IR04	IR04MW13A	1,1,2,2-Tetrachloroethane	79345	2.00	MCL				1.00	0.06	1	-	3
IR04	IR04MW13A	1,1-Dichloroethane	75343	55.32	MCL				5.00	811.11	**3**	-	3
IR04	IR04MW13A	1,1-Dichloroethene	75354	37.65	MCL				6.00	0.05	**3**	-	3
IR04	IR04MW13A	1,2-Dichloroethane	107062	1.00	MCL			5.00	0.50	0.12	1	-	3
IR04	IR04MW13A	Tetrachloroethene	127184	51.84	MCL				5.00	1.08	**3**	-	3
IR04	IR04MW13A	Trichloroethene	79016	22.67	MCL				5.00	1.64	**3**	-	3
IR04	IR04MW31A	Arsenic	7440382	208.00	NAWQC	27.34	36.00	50.00	50.00	0.04	1	-	3
IR04	IR04MW35A	Nickel	7440020	147.00	NAWQC	96.48	8.20		100.00	730.00	1	-	3
IR04	IR04MW35A	Tetrachloroethene	127184	5.43	MCL				5.00	1.08	1	-	3
IR04	IR04MW36A	Arsenic	7440382	168.67	NAWQC	27.34	36.00	50.00	50.00	0.04	**2**	-	3
IR04	IR04MW37A	Trichloroethene	79016	7.87	MCL				5.00	1.64	1	yes	3
IR04	IR04MW39A	Trichloroethene	79016	10.30	MCL				5.00	1.64	**2**	-	3
IR04	IR04MW40A	Cadmium	7440439	13.00	0.00	5.08	9.30	5.00	5.00	18.25	1	yes	3
IR04	IR04MW40A	Lead	7439921	15.39	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR04	IR04MW40A	Nickel	7440020	302.00	NAWQC	96.48	8.20		100.00	730.00	1	yes	3
IR05	IR05MW73A	Aroclor-1260	11096825	0.79	MCL			0.50		0.03	1	-	3
IR05	IR05MW77A	Lead	7439921	31.39	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR05	IR05MW85A	Arsenic	7440382	148.00	NAWQC	27.34	36.00	50.00	50.00	0.04	**2**	-	4
IR05	IR05MW85A	Cadmium	7440439	7.20	MCL	5.08	9.30	5.00	5.00	18.25	1	yes	4
IR05	IR05MW85A	Copper	7440508	53.50	NAWQC	28.04	2.40		1,300.00	1,355.71	**3**	-	4
IR05	IR05MW85A	Mercury	7439976	11.00	NAWQC	0.60	0.03		2.00	11.00	**2**	yes	4
IR05	IR05MW85A	Phenanthrene	85018	52.00	NAWQC		4.60			6.20	**2**	-	3
IR11	IR11MW25A	Carbon Tetrachloride	56235	2.00	MCL			5.00	0.50	0.17	1	-	4
IR11	IR11MW25A	Tetrachloroethene	127184	38.00	MCL				5.00	1.08	1	-	4
IR11	IR11MW26A	Tetrachloroethene	127184	21.00	MCL				5.00	1.08	1	-	4
IR11	IR11MW27A	Copper	7440508	98.00	0.00	28.04	5.08	9.30	5.00	5.00	1	-	4
IR11	IR11MW27A	Tetrachloroethene	127184	9.00	MCL				5.00	1.08	1	-	4

TABLE 1
SUMMARY OF RESULTS OFGROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL E GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

IR Site	Station	Analyte Name	CAS Number	Maximum Detection	Criteria Exceeded[g]	HGAL[a]	NAWQC[b]	EPA Primary MCL (mg/L)[c]	California Primary MCL (mg/L)[b]	EPA Region 9 Tap Water PRG (mg/L)[d]	Number of Sampling Events that Exceed MCLs	Two or More Subsequent Sampling Events below Criteria[e]	Number of Sampling Events
IR12	IR12MW13A	1,1-Dichloroethane	75343	6.26	MCL				5.00	811.11	1	-	3
IR12	IR12MW17A	1,1-Dichloroethane	75343	17.00	MCL				5.00	811.11	1	-	3
IR12	IR12MW17A	Barium	7440393	1,040.00	MCL	504.20		2,000.00	1,000.00	2,554.99	1	-	3
IR12	IR12MW17A	Benzene	71432	6.00	MCL			5.00	1.00	0.41	1	-	3
IR12	IR12MW18A	Arsenic	7440382	62.80	NAWQC	27.34	36.00	50.00	50.00	0.04	1	-	3
IR12	IR12MW18A	Nickel	7440020	213.56	NAWQC	96.48	8.20		100.00	730.00	**3**	-	3
IR12	IR12MW19A	1,1-Dichloroethane	75343	28.13	MCL				5.00	811.11	**3**	-	3
IR12	IR12MW19A	1,2-Dichloroethane	107062	2.00	MCL			5.00	0.50	0.12	**2**	-	3
IR12	IR12MW19A	Tetrachloroethene	127184	6.88	MCL				5.00	1.08	**2**	-	3
IR12	IR12MW20A	Arsenic	7440382	45.45	NAWQC	27.34	36.00	50.00	50.00	0.04	1	-	3
IR12	IR12MW21A	Arsenic	7440382	37.44	NAWQC	27.34	36.00	50.00	50.00	0.04	1	-	4
IR12	IR12MW21A	Barium	7440393	1,090.00	MCL	504.20		2,000.00	1,000.00	2,554.99	1	-	4
IR12	IR12MW21A	Cadmium	7440439	6.00	MCL	5.08	9.30	5.00	5.00	18.25	1	-	4
IR12	IR12MW21A	Phenanthrene	85018	210.00	NAWQC		4.60			6.20	1	yes	4
IR14	IR14MW09A	Mercury	7439976	0.91	NAWQC	0.60	0.03		2.00	11.00	1	-	3
IR14	IR14MW09A	Nickel	7440020	130.00	NAWQC	96.48	8.20		100.00	730.00	**3**	-	3
IR14	IR14MW10A	Antimony	7440360	43.60	MCL	43.26	500.00	6.00	6.00	14.60	**2**	-	3
IR14	IR14MW10A	Cadmium	7440439	12.60	0.00	5.08	9.30	5.00	5.00	18.25	1	yes	3
IR14	IR14MW10A	Lead	7439921	18.02	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR14	IR14MW12A	Cadmium	7440439	14.10	0.00	5.08	9.30	5.00	5.00	18.25	1	yes	3
IR14	IR14MW12A	Nickel	7440020	102.00	NAWQC	96.48	8.20		100.00	730.00	1	yes	3
IR14	IR14MW13A	Barium	7440393	3,918.40	MCL	504.20		2,000.00	1,000.00	2,554.99	**2**	-	4
IR14	IR14MW13A	Phenanthrene	85018	35.00	NAWQC		4.60			6.20	1	yes	4
IR15	IR15MW06A	1,1-Dichloroethane	75343	8.71	MCL				5.00	811.11	1	-	3
IR15	IR15MW06A	Lead	7439921	127.03	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR15	IR15MW06A	Thallium	7440280	18.00	MCL	12.97		2.00	2.00		1	-	3
IR15	IR15MW07A	Lead	7439921	35.51	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR15	IR15MW07A	Silver	7440224	7.50	NAWQC	7.43	0.92			182.50	1	yes	3
IR15	IR15MW08A	Phenanthrene	85018	25.00	NAWQC		4.60			6.20	1	yes	3
IR15	IR15MW09F	Bis(2-ethylhexyl)phthalate	117817	110.00	MCL		360.00		4.00	4.80	1	yes	3
IR15	IR15MW10F	Arsenic	7440382	67.60	NAWQC	27.34	36.00	50.00	50.00	0.04	1	-	3
IR36	IR36MW125A	Trichloroethene	79016	1,000.00	MCL				5.00	1.64	**3**	-	3
IR36	IR36MW125A	Vinyl chloride	75014	25.00	MCL			2.00	0.50	0.02	**2**	-	3
IR36	IR36MW135A	Cadmium	7440439	10.50	0.00	5.08	9.30	5.00	5.00	18.25	1	yes	3
IR36	PA36MW03A	4,4'-DDT	50293	0.00	NAWQC		0.00			0.20	1	yes	3
IR36	PA36MW03A	Copper	7440508	366.00	NAWQC	28.04	2.40		1,300.00	1,355.71	**2**	-	3
IR36	PA36MW03A	Zinc	7440666	1,340.00	NAWQC	75.68	81.00			10,949.88	**2**	-	3

TABLE 1
SUMMARY OF RESULTS OFGROUNDWATER SAMPLES THAT EXCEED SCREENING CRITERIA
PARCEL E GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(PAGE 11 OF 11)

IR Site	Station	Analyte Name	CAS Number	Maximum Detection	Criteria Exceeded[g]	HGAL[a]	NAWQC[b]	EPA Primary MCL (mg/L)[c]	California Primary MCL (mg/L)[b]	EPA Region 9 Tap Water PRG (mg/L)[d]	Number of Sampling Events that Exceed MCLs	Two or More Subsequent Sampling Events below Criteria[e]	Number of Sampling Events
IR36	PA36MW04A	Copper	7440508	38.50	NAWQC	28.04	2.40		1,300.00	1,355.71	**2**	-	3
IR36	PA36MW04A	Endrin	72208	0.00	NAWQC		0.00	2.00	2.00	10.95	1	yes	3
IR36	PA36MW04A	Trichloroethene	79016	6.00	MCL				5.00	1.64	1	-	3
IR36	PA36MW04A	Vinyl chloride	75014	4.00	MCL			2.00	0.50	0.02	**2**	-	3
IR36	PA36MW06A	4,4'-DDT	50293	0.02	NAWQC		0.00			0.20	1	yes	3
IR36	PA36MW07A	Heptachlor	76448	0.13	NAWQC		0.00	0.40	0.01	0.01	1	yes	3
IR39	IR39MW21A	Aroclor-1260	11096825	0.60	MCL			0.50			1	yes	
IR39	IR39MW21A	Benzene	71432	1,500.00	NAWQC			5.00	1.00	0.41	**3**	-	
IR39	IR39MW21A	Heptachlor Epoxide	1024573	0.02	NAWQC		0.00	0.40	0.01	0.01	1	-	
IR39	IR39MW23A	Aluminum	7429905	4,160.00	MCL				1,000.00	36,498.67	1	-	
IR39	IR39MW33A	Barium	7440393	3,880.00	MCL	504.20		2,000.00	1,000.00	2,554.99	**3**	-	
IR39	IR39MW33A	Benzene	71432	4.00	NAWQC			5.00	1.00	0.41	**3**	-	
IR50	PA50MW10A	Cadmium	7440439	7.20	MCL	5.08	9.30	5.00	5.00	18.25	1	-	3
IR50	PA50MW10A	Copper	7440508	275.00	NAWQC	28.04	2.40		1,300.00	1,355.71	1	-	3
IR50	PA50MW10A	Lead	7439921	133.00	NAWQC	14.44	8.10	15.00	15.00		1	-	3
IR50	PA50MW10A	Zinc	7440666	396.00	NAWQC	75.68	81.00			10,949.88	1	-	3
IR56	IR56MW39A	Benzene	71432	2.00	MCL			5.00	1.00	0.41	**2**	-	3

Notes: Values are highlighted in bold where criteria is exceeded in more than one sample event.

µg/L Microgram/liter
DDT Dichlorodiphenyltrichloroethane
EPA U.S. Environmental Protection Agency
HGAL Hunters Point Groundwater Ambien Limit
IR Installation Restoration
MCL Maximum Contaminant Limit
NAWQC National Ambient Water Quality Goal
PRG Preliminary remediation goal

a PRC Environmental Management, Inc. 1996. "Estimation of Hunters Point Shipyard Groundwater Ambient Levels Technical Memorandum." September 16.
b California Environmental Protection Agency, Regional Water Quality Control Board, Central Region. 2000. "A Compilation of Water Quality Goals." August
c EPA office of Groundwater and Drinking Water. 2000. "Current Drinking Water Standards". Accessed on September 26, 2000.
On-line address: http://www.epa.tov.OGWDW/wot/appa.html
d EPA. 1999. "Region 9 Preliminary Remediation Goals 1999." October. PRGs are presented for information only.
e This column lists "yes" where two or more of the most recent samples were below criteria.
f Criteria exceeded lists criteria above the Hunters Point Ambient Level that are exceeded in that sample, either NAWQC or MCL, which ever is exceeded

TABLE 2.
PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
(Page 1 of 13)

IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR-01 (A-aquifer)	IR01MW03A	Aluminum	Confirm extent of listed metals
		Copper	
		Lead	
		Zinc	
		PCBs	Confirm extent of PCBs
		SVOCs	Confirm extent of 1,4-dichlorobenzene
		VOCs	Confirm attenuation and extent of benzene
		TDS	Obtain TDS data for beneficial use analysis
	IR01MW05A	Nickel	Confirm extent of listed metals
		Aluminum	
		Zinc	
		PCBs	Confirm extent of PCBs
		VOCs	Confirm attenuation and extent of benzene
		TDS	Obtain TDS data for beneficial use analysis
	IR01MW07A	TPH-ext, TPH-purg	Confirm attenuation and extent of TPH
		TDS	Obtain TDS data for beneficial use analysis
	IR01MW16A	Aluminum	Confirm extent of listed metals
		Copper	
		Lead	
		Zinc	
		PCBs	Confirm extent of PCBs
		TPH-ext, TPH-purg	Confirm attenuation and extent of TPH
		VOCs	Confirm attenuation and extent of benzene
		TDS	Obtain TDS data for beneficial use analysis
	IR01MW18A	Aluminum	Confirm extent of listed metals
		Chromium	
		Copper	
		Lead	
		Mercury	
		Nickel	
		Zinc	
		PCBs	Confirm extent of PCBs
		SVOCs	Confirm extent of phenanthrene
		TPH-ext, TPH-purg	Confirm attenuation and extent of TPH
		VOCs	Confirm attenuation and extent of benzene
		Radium-226 and -228	Evaluate radioactivity migration from the landfill
		TDS	Obtain TDS data for beneficial use analysis
	IR01MW31A	Lead	Confirm extent of lead
		PCBs	Confirm extent of PCBs
		VOCs	Confirm attenuation and extent of benzene
			Confirm attenuation and migration of HVOCs
		TDS	Obtain TDS data for beneficial use analysis
	IR01MW366A	Cadmium	Confirm extent of listed metals
		Copper	
		Mercury	
		Nickel	
		Zinc	
		SVOCs	
		TPH-ext, TPH-purg	Confirm attenuation and extent of TPH

TABLE 2.
PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
(Page 2 of 13)

IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MW366A (cont.)	Radium-226 and -228 TDS	Evaluate radioactivity migration from the landfill Obtain TDS data for beneficial use analysis
	IR01MW367A	Pesticides TPH-ext, TPH-purg Motor Oil Range Organics VOCs Radium-226 and -228 TDS	Confirm extent of pesticides Confirm attenuation and extent of TPH Confirm attenuation and extent of benzene; evaluate VOC migration Evaluate radioactivity migration from the landfill Obtain TDS data for beneficial use analysis
	IR01MW38A	VOCs TDS	Confirm attenuation and extent of benzene Obtain TDS data for beneficial use analysis
	IR01MW400A	PCBs TDS	Confirm extent of PCBs Obtain TDS data for beneficial use analysis
	IR01MW401A	VOCs, SVOCs, metals TDS	Evaluate wells at Site Periphery Obtain TDS data for beneficial use analysis
	IR01MW402A	TPH-ext, TPH-purg TDS	Confirm attenuation and extent of TPH Obtain TDS data for beneficial use analysis
	IR01MW403A	VOCs, SVOCs, metals TDS	Evaluate wells at Site Periphery Obtain TDS data for beneficial use analysis
	IR01MW42A	VOCs TDS	Evaluate extent of VOC migration Obtain TDS data for beneficial use analysis
	IR01MW43A	Antimony PCBs Pesticides SVOCs TPH-ext, TPH-purg VOCs TDS	Confirm extent of antimony Confirm extent of pesticides Confirm extent of pesticides Confirm extent of 1,4-dichlorobenzene Confirm attenuation and extent of TPH Confirm attenuation and extent of HVOCs, VOCs and benzene Obtain TDS data for beneficial use analysis
	IR01MW44A	PCBs Pesticides TPH-ext, TPH-purg TDS	Confirm extent of PCBs Confirm extent of pesticides Confirm attenuation and extent of TPH Obtain TDS data for beneficial use analysis
	IR01MW48A	Aluminum Barium Chromium, Chromium VI Copper Lead Zinc VOCs TDS	Confirm extent of listed metals Confirm attenuation and extent of benzene Obtain TDS data for beneficial use analysis
	IR01MW58A	Barium TPH-ext, TPH-purg VOCs TDS	Confirm extent of listed metals Confirm attenuation and extent of TPH Confirm attenuation and extent of benzene Obtain TDS data for beneficial use analysis
	IR01MW62A	Aluminum Antimony Arsenic Barium	Confirm extent of listed metals

TABLE 2.
PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA

IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MW62A (cont.)	Cadmium	
		Chromium	
		Copper	
		Lead	
		Mercury	
		Nickel	
		Zinc	
		SVOCs	Confirm extent of PAHs and SVOCs
		TDS	Obtain TDS data for beneficial use analysis
	IR01MW63A	Barium	Confirm extent of barium
		TDS	Obtain TDS data for beneficial use analysis
	IR01MWI-2	Aluminum	Confirm extent of listed metals
		Arsenic	
		Barium	
		Beryllium	
		Chromium	
		Copper	
		Lead	
		Mercury	
		Nickel	
		Zinc	
		Radium-226 and -228	Evaluate radioactivity migration from the landfill
		TDS	Obtain TDS data for beneficial use analysis
	IR01MWI-3	Nickel	Confirm extent of listed metals
		Zinc	
		PCBs	
		SVOCs	Confirm extent of PAHs
		TPH-ext, TPH-purg	Confirm attenuation and extent of TPH
		VOCs	Confirm attenuation and extent of benzene
		TDS	Obtain TDS data for beneficial use analysis
	IR01MWI-5	Antimony	Confirm extent of listed metals
		Barium	
		Chromium	
		Copper	
		Lead	
		Mercury	
		Nickel	
		Zinc	
		PCBs	Confirm extent of PCBs and pesticides
		SVOCs	Confirm extent of SVOCs
		VOCs	Confirm attenuation and extent of benzene
		Radium-226 and -228	Evaluate radioactivity migration from the landfill
		TDS	Obtain TDS data for beneficial use analysis
	IR01MWI-7	VOCs, SVOCs, metals	Evaluate wells near shore
		TDS	Obtain TDS data for beneficial use analysis
	IR01MWI-8	VOCs, SVOCs, metals	Evaluate wells near shore
		TDS	Obtain TDS data for beneficial use analysis
	IR01MWI-9	Aluminum	Confirm extent of listed metals
		Antimony	

TABLE 2.
PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA

IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR-01 (A-aquifer) (cont.)	IR01MWI-9 (cont.)	Arsenic Barium Cadmium Chromium Copper Lead Mercury Nickel Silver Zinc	
		PCBs	Confirm extent of PCBs
		SVOCs	Confirm extent of PAHs
		TDS	Obtain TDS data for beneficial use analysis
IR-01 (B-aquifer)	IR01MW02B	Aluminum	Confirm extent of aluminum
		Chromium VI Chromium	Confirm the extent of chromium VI and chromium
		SVOCs	Confirm extent of phenanthrene
		VOCs	Evaluate possible migration from A-aquifer
		TDS	Obtain TDS data for beneficial use analysis
	IR01MW09B	VOCs, TPH	Evaluate possible TPH, benzene migration from A-aquifer
		TDS	Obtain TDS data for beneficial use analysis
	IR01MW17B	Aluminum Antimony Cadmium	Confirm extent of listed metals
		PCBs, VOCs	Evaluate possible PCB and benzene migration from A-aquifer
		SVOCs	Confirm presence or extent of bis(2-ethyl hexyl phthalate)
		TDS	Obtain TDS data for beneficial use analysis
	IR01MW26B	VOCs, TPH	Evaluate possible TPH, benzene migration from A-aquifer
		Radium-226 and -228	Evaluate radioactivity migration from the landfill
		TDS	Obtain TDS data for beneficial use analysis
	IR01MW47B	VOCs	Confirm extent and attenuation of HVOCs
		TDS	Obtain TDS data for beneficial use analysis
	IR01MW53B	Cadmium	Confirm extent of cadmium
		VOCs, TPH	Evaluate possible TPH, benzene migration from A-aquifer
		TDS	Obtain TDS data for beneficial use analysis

TABLE 2.
PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
(Page 5 of 13)

IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR-02 (A-aquifer)	IR02MW97A	PCBs, VOCs, SVOCs Barium, Arsenic, Nickel TPH-ext, TPH-purg TDS	Confirm extent of IR03 plumes: PCBs, Barium, Arsenic, Nickel, VOCs, pentachlorophenol and TPH Obtain TDS data for beneficial use analysis
	IR02MW101A1	Aluminum Chromium Nickel SVOCs TDS	Confirm the extent of listed metals and chromium VI Confirm extent of pentachlorophenol Obtain TDS data for beneficial use analysis
	IR02MW101A2	Barium Cadmium TDS	Confirm extent of listed metals Obtain TDS data for beneficial use analysis
	IR02MW114A1	Cadmium TDS	Confirm extent of cadmium Obtain TDS data for beneficial use analysis
	IR02MW114A2	Aluminum Cadmium Chromium Copper Nickel TDS	Confirm extent of listed metals Obtain TDS data for beneficial use analysis
	IR02MW114A3	Barium Cadmium TDS	Confirm extent of listed metals Obtain TDS data for beneficial use analysis
	IR02MW126A	Barium Copper Lead Zinc PCBs TDS	Confirm extent of listed metals Confirm extent of PCBs Obtain TDS data for beneficial use analysis
	IR02MW141A	Aluminum Antimony Barium Cadmium Chromium Copper Lead Mercury Nickel Silver Zinc PCBs TDS	Confirm extent of listed metals Confirm extent of PCBs Obtain TDS data for beneficial use analysis
	IR02MW146A	PCBs TPH-ext, TPH-purg VOCs SVOCs Barium, Arsenic, Nickel TDS	Confirm extent of PCBs Confirm attenuation and extent of TPH Confirm attenuation and extent of benzene Confirm extent of IR03 plumes: pentachlorophenol, listed metals, VOCs, and PCBs Obtain TDS data for beneficial use analysis

TABLE 2.
PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA

IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR-02 (A-aquifer) (cont.)	IR02MW147A	SVOCs TDS	Confirm extent of pentachlorophenol Obtain TDS data for beneficial use analysis
	IR02MW173A	Arsenic Barium SVOCs TPH-ext, TPH-purg VOCs TDS	Confirm extent of listed metals Confirm extent of phenanthrene Confirm attenuation and extent of TPH Confirm attenuation and extent of benzene Obtain TDS data for beneficial use analysis
	IR02MW175A	VOCs TDS	Confirm attenuation and extent of HVOCs Obtain TDS data for beneficial use analysis
	IR02MW179A	Cadmium VOCs SVOCs TDS	Confirm extent of cadmium Confirm extent of VOCs at IR02MW175A Confirm extent of pentachlorophenol at IR02MW183A Obtain TDS data for beneficial use analysis
	IR02MW206A1	VOCs TDS	Confirm extent of VOCs near IR02MW175A Obtain TDS data for beneficial use analysis
	IR02MW206A1	VOCs TDS	Confirm extent of VOCs near IR02MW175A Obtain TDS data for beneficial use analysis
	IR02MW298A	Cadmium, copper, chromium TDS	Confirm extent of metals at IR02MW114A2 (cadmium, chromium, copper) Obtain TDS data for beneficial use analysis
	IR02MW299A	VOCs TDS	Confirm attenuation and extent of HVOCs Obtain TDS data for beneficial use analysis
	IR02MW300A	Copper Zinc VOCs TDS	Confirm extent of listed metals Confirm extent of VOCs near IR02MW175A Obtain TDS data for beneficial use analysis
	IR02MW372A	Pesticides VOCs TDS	Confirm extent of pesticides Confirm attenuation and extent of benzene and HVOCs Obtain TDS data for beneficial use analysis
	IR02MW373A	Antimony Cadmium Copper Lead Nickel Zinc PCBs TDS	Confirm extent of listed metals Confirm extent of PCBs Obtain TDS data for beneficial use analysis
	IR02MW89A	Aluminum Nickel TDS	Confirm extent of aluminum and nickel Obtain TDS data for beneficial use analysis
	IR02MW93A	Nickel TDS	Confirm extent of nickel Obtain TDS data for beneficial use analysis
	IR02MW97A	Cadmium Pesticides TDS	Confirm extent of cadmium Confirm extent of pesticides Obtain TDS data for beneficial use analysis

TABLE 2.
PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR0-2 (B-aquifer)	IR02MW127B	VOCs, pesticides	Assess migration from A-aquifer
		TDS	Obtain TDS data for beneficial use analysis
	IR02MW210B	VOCs	Evaluate possible HVOC migration from A-aquifer
		TDS	Obtain TDS data for beneficial use analysis
	IR02MWB-1	Aluminum	Confirm extent of listed metals
		Arsenic	
		Chromium	
		Copper	
		Nickel	
		Zinc	
		TDS	Obtain TDS data for beneficial use analysis
	IR02MWB-2	Aluminum	Confirm extent of listed metals
		Chromium	
		Copper	
		Lead	
		Mercury	
		Nickel	
		Thallium	
		Zinc	
		VOCs	Confirm attenuation and extent of VOCS
		TDS	Obtain TDS data for beneficial use analysis
	IR02MWB-3	Aluminum	Confirm extent of listed metals
		Antimony	
		Cadmium	
		Chromium	
		Copper	
		Lead	
		Mercury	
		Nickel	
		Zinc	
		SVOCs	Confirm extent of PAHs and Pentachlorophenol
		TDS	Obtain TDS data for beneficial use analysis
	IR02MWB-5	PCBs	Confirm extent of PCBs
		TDS	Obtain TDS data for beneficial use analysis
IR-03 (A-aquifer)	IR03MW218A1	Barium	Confirm extent of listed metals
		Lead	
		PCBs	Confirm extent of PCBs
		SVOCs	Confirm extent of phenanthrene
		TDS	Obtain TDS data for beneficial use analysis
	IR03MW218A2	Barium	Confirm extent of listed metals
		Copper	
		Lead	
		Zinc	
		TPH-ext, TPH-purg	Confirm attenuation and extent of TPH
		VOCs	Confirm attenuation and extent of benzene
		TDS	Obtain TDS data for beneficial use analysis

TABLE 2.
PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR-03 (A-aquifer) (cont.)	IR03MW218A3	Barium	Confirm extent of barium
		VOCs	Confirm attenuation and extent of benzene
		TDS	Obtain TDS data for beneficial use analysis
	IR03MW224A	Aluminum	Confirm extent of listed metals
		Chromium	Confirm extent of chromium and chromium VI
		Copper	
		SVOCs, VOCs, TPH	Confirm extent of IR03 contamination: SVOCs,
		Arsenic, barium, nickel	VOCs, TPH, arsenic, barium, nickel.
		PCBs	Confirm extent of PCBs
		TDS	Obtain TDS data for beneficial use analysis
	IR03MW225A	PCBs	Confirm extent of PCBs
		SVOCs	Confirm extent of SVOCs
		TPH-ext, TPH-purg	Confirm attenuation and extent of TPH
		VOCs	Confirm extent of HVOCs
			Confirm attenuation and extent of benzene
		TDS	Obtain TDS data for beneficial use analysis
	IR03MW226A	Aluminum	Confirm extent of listed metals
		Antimony	
		Barium	
		Chromium	
		Copper	
		Lead	
		Mercury	
		Nickel	
		Zinc	
		PCBs	Confirm extent of PCBs
		SVOCs	Confirm extent of phenanthrene
		TPH-ext, TPH-purg	Confirm attenuation and extent of TPH
		VOCs	Confirm attenuation and extent of HVOCs and benzene
		TDS	Obtain TDS data for beneficial use analysis
	IR03MW342A	Aluminum	Confirm extent of aluminum and barium
		Barium	
		SVOCs, TPH, VOCs	Confirm extent of IR03 plumes: pentachlorophenol,
		Barium, Arsenic, Nickel	listed metals, VOCs, PCBs and TPH
		VOCs	Confirm attenuation and extent of benzene
		TDS	Obtain TDS data for beneficial use analysis
	IR03MW369A	SVOCs	Confirm extent of phenanthrene
		TPH-ext, TPH-purg	Confirm attenuation and extent of TPH
		VOCs	Confirm attenuation and extent of benzene
		PCBs	Confirm extent of IR03 plumes: pentachlorophenol,
		Barium, Arsenic, Nickel	listed metals, VOCs, PCBs and TPH
		TDS	Obtain TDS data for beneficial use analysis
	IR03MW370A	Barium, Arsenic, Nickel	Confirm extent of barium and metals at IR03 plume
		PCBs	Confirm extent of PCBs from IR03 plume
		SVOCs	Confirm extent of phenanthrene
		TPH-ext, TPH-purg	Confirm attenuation and extent of TPH
		VOCs	Confirm attenuation and extent of benzene
		TDS	Obtain TDS data for beneficial use analysis

TABLE 2.
PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR-03 (A-aquifer) (cont.)	IR03MW371A	PCBs	Confirm extent of PCBs
		SVOCs, VOCs	Confirm extent of IR03 plumes: pentachlorophenol,
		Barium, Arsenic, Nickel	listed metals, VOCs, PCBs and TPH
		TPH-ext, TPH-purg	Confirm attenuation and extent of TPH
		TDS	Obtain TDS data for beneficial use analysis
	IR03MWO-1	Aluminum	Confirm extent of listed metals and of IR03 plume
		Arsenic	
		Barium	
		Chromium	
		Copper	
		Lead	
		Mercury	
		Nickel	
		Zinc	
		PCBs	Confirm extent of PCBs
		SVOCs	Confirm extent of SVOCs
		VOCs	Confirm attenuation and extent of benzene
			Confirm attenuation and extent of HVOCS
		TDS	Obtain TDS data for beneficial use analysis
	IR03MW228B	Cadmium	Confirm extent of cadmium
		Barium, VOCs	Evaluate migration from A-aquifer
		TDS	Obtain TDS data for beneficial use analysis
IR-04 (A-aquifer)	IR04MW13A	VOCs	Confirm attenuation and extent of HVOCS
		TDS	Obtain TDS data for beneficial use analysis
	IR04MW31A	Arsenic	Confirm extent of arsenic
		VOCs	Evaluate migration from A-aquifer
		TDS	Obtain TDS data for beneficial use analysis
	IR04MW35A	VOCs	Confirm attenuation and extent of HVOCS
		TDS	Obtain TDS data for beneficial use analysis
	IR04MW36A	Arsenic	Confirm extent of arsenic
		TDS	Obtain TDS data for beneficial use analysis
	IR04MW37A	VOCs	Confirm attenuation and extent of HVOCS
		TDS	Obtain TDS data for beneficial use analysis
	IR04MW38A	VOCs	Evaluate potential for VOC migration
		TDS	Obtain TDS data for beneficial use analysis
	IR04MW39A	VOCs	Confirm attenuation and extent of HVOCS
		TDS	Obtain TDS data for beneficial use analysis
	IR04MW40A	Lead	Confirm extent of lead
		TDS	Obtain TDS data for beneficial use analysis
IR-05 (A-aquifer)	IR05MW73A	PCBs	Confirm extent of PCBs
		TDS	Obtain TDS data for beneficial use analysis
	IR05MW77A	Lead	Confirm extent of lead
		TDS	Obtain TDS data for beneficial use analysis
	IR05MW85A	Arsenic	Confirm extent of listed metals
		Copper	
		SVOCs	Confirm extent of phenanthrene
		TDS	Obtain TDS data for beneficial use analysis

IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR-11 (A-aquifer)	IR11MW25A	VOCs TDS	Confirm attenuation and extent of HVOCS Obtain TDS data for beneficial use analysis
	IR11MW26A	VOCs TDS	Confirm attenuation and extent of HVOCS Obtain TDS data for beneficial use analysis
	IR11MW27A	Copper VOCs TDS	Confirm extent of copper Confirm attenuation and extent of HVOCS Obtain TDS data for beneficial use analysis
IR-12	IR12MW11A	VOCs TDS	Evaluate potential for VOC migration Obtain TDS data for beneficial use analysis
	IR12MW13A	VOCs TDS	Confirm attenuation and extent of HVOCS Obtain TDS data for beneficial use analysis
	IR12MW14A	VOCs TDS	Evaluate potential for VOC migration Obtain TDS data for beneficial use analysis
	IR12MW17A	Barium TPH-ext, TPH-purg VOCs TDS	Confirm extent of barium Confirm attenuation and extent of TPH Confirm attenuation and extent of HVOCS Confirm extent and attenuation of benzene Obtain TDS data for beneficial use analysis
	IR12MW18A	Arsenic Nickel VOCs TDS	Confirm extent of listed metals Evaluate potential for VOC migration Obtain TDS data for beneficial use analysis
	IR12MW19A	VOCs TDS	Confirm attenuation and extent of HVOCs Obtain TDS data for beneficial use analysis
	IR12MW20A	Arsenic VOCs TDS	Confirm extent of arsenic Evaluate potential for VOC migration Obtain TDS data for beneficial use analysis
	IR12MW21A	Arsenic Barium Cadmium VOCs TPH-ext, TPH-purg TDS	Confirm extent of listed metals Evaluate possible HVOC migration Confirm extent and attenuation of TPH Obtain TDS data for beneficial use analysis
	IR12MW22A (new well)	VOCs TDS	Evaluate possible VOC migration Obtain TDS data for beneficial use analysis
IR-14	IR14MW09A	Mercury Nickel TPH-ext, TPH-purg TDS	Confirm extent of listed metals Confirm extent of TPH contamination at IR14MW13A and IR15MW08A plume Obtain TDS data for beneficial use analysis
	IR14MW10A	Antimony Lead PCBs, VOCs, SVOCs Barium, Arsenic, Nickel TDS	Confirm extent of listed metals Confirm extent of IR03 plumes: PCBs, barium, arsenic, nickel, VOCs, pentachlorophenol Obtain TDS data for beneficial use analysis
	IR14MW12A	TPH-ext, TPH-purg TDS	Confirm extent of TPH contamination at IR14MW13A and IR15MW08A plume Obtain TDS data for beneficial use analysis

IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR-14 (cont.)	IR14MW13A	Barium TPH-ext, TPH-purg TDS	Confirm extent of barium Confirm extent and attenuation of TPH Obtain TDS data for beneficial use analysis
IR-15 (A-aquifer)	IR15MW06A	Lead Thallium VOCs TPH-ext, TPH-purg TDS	Confirm extent of listed metals Confirm attenuation and extent of HVOCS Confirm extent of TPH contamination at IR14MW13A and IR15MW08A plume Obtain TDS data for beneficial use analysis
	IR15MW07A	Lead TPH-ext, TPH-purg TDS	Confirm extent of lead Confirm extent of TPH contamination at IR14MW13A and IR15MW08A plume Obtain TDS data for beneficial use analysis
	IR15MW08A	TPH-ext, TPH-purg TDS	Confirm extent and attenuation of TPH Obtain TDS data for beneficial use analysis
IR-15 (F-aquifer)	IR15MW09F	VOCs TDS	Evaluate potential for VOC migration Obtain TDS data for beneficial use analysis
	IR15MW10F	Arsenic VOCs TDS	Confirm extent of arsenic Evaluate potential for VOC migration Obtain TDS data for beneficial use analysis
IR-36 (A-aquifer)	IR36MW11A	TPH-ext, TPH-purg VOCs TDS	Confirm extent and attenuation of TPH Evaluate potential for VOC migration Obtain TDS data for beneficial use analysis
	IR36MW126A	VOCs TDS	Evaluate possible HVOC migration other wells Obtain TDS data for beneficial use analysis
	IR36MW127A	VOCs TDS	Evaluate possible HVOC migration other wells Obtain TDS data for beneficial use analysis
	IR36MW125A	VOCs TDS	Confirm attenuation and extent of HVOCS Obtain TDS data for beneficial use analysis
	IR36MW12A	TPH-ext, TPH-purg TDS	Confirm extent and attenuation of TPH Obtain TDS data for beneficial use analysis
	IR36MW14A	VOCs TDS	Confirm extent of VOCs to the north Obtain TDS data for beneficial use analysis
	IR36MW128A	VOCs TDS	Confirm extent of VOCs to the north Obtain TDS data for beneficial use analysis
	IR36MW144A (new well)	VOCs TDS	Confirm extent of HVOCs near building 406 Obtain TDS data for beneficial use analysis
	PA36MW03A	Copper Zinc TDS	Confirm extent of listed metals Obtain TDS data for beneficial use analysis
	PA36MW04A	Copper VOCs TDS	Confirm extent of copper Confirm extent or attenuation of HVOCs Obtain TDS data for beneficial use analysis
	PA36MW07A	Pesticides VOCs TDS	Confirm reduction of heptachlor Confirm extent or attenuation of HVOCs Obtain TDS data for beneficial use analysis
	PA36MW08A	TPH-ext, TPH-purg TDS	Confirm extent and attenuation of TPH Obtain TDS data for beneficial use analysis

TABLE 2.
PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA

IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR-36 (B-aquifer)	IR36MW120B	VOCs TDS	Evaluate possible HVOC migration from A-aquifer Obtain TDS data for beneficial use analysis
	IR36MW123B	VOCs TDS	Evaluate possible HVOC migration from A-aquifer Obtain TDS data for beneficial use analysis
	IR36MW129B	VOCs TDS	Evaluate possible HVOC migration from A-aquifer Obtain TDS data for beneficial use analysis
IR-39 (A-aquifer)	IR39MW21A	Antimony Pesticides VOCs TDS	Confirm extent of antimony Confirm extent of heptachlor Confirm extent or attenuation of benzene Obtain TDS data for beneficial use analysis
	IR39MW23A	Aluminum TDS	Confirm extent of aluminum Obtain TDS data for beneficial use analysis
	IR39MW33A	Barium VOCs TDS	Confirm extent of barium Confirm extent and attenuation of benzene Obtain TDS data for beneficial use analysis
IR-50 (A-aquifer)	PA50MW10A	Cadmium Copper Lead Zinc VOCs TDS	Confirm extent of listed metals Evaluate possible migration of VOCs Obtain TDS data for beneficial use analysis
IR-56 (A-aquifer)	IR56MW39A	TPH-ext, TPH-purg VOCs TDS	Confirm extent and attenuation of TPH Confirm extent and attenuation of benzene Obtain TDS data for beneficial use analysis
IR-72 (A-aquifer)	IR72MW32A	TPH-ext, TPH-purg VOCs TDS	Confirm extent and attenuation of TPH Evaluate possible migration of VOCs Obtain TDS data for beneficial use analysis
IR-73 (A-aquifer)	IR73MW13A (new well if necessary)	TPH-ext, TPH-purg TDS	Confirm extent and attenuation of TPH Obtain TDS data for beneficial use analysis
	IR73MW14A (new well if necessary)	TPH-ext, TPH-purg TDS	Confirm extent and attenuation of TPH Obtain TDS data for beneficial use analysis
	IR73MW15A (new well if necessary)	TPH-ext, TPH-purg TDS	Confirm extent and attenuation of TPH Obtain TDS data for beneficial use analysis
	IR73MW16A (new well if necessary)	TPH-ext, TPH-purg TDS	Confirm extent and attenuation of TPH Obtain TDS data for beneficial use analysis
IR-75 (A-aquifer)	IR75MW09 (new well if necessary)	VOCs, SVOCs, Pesticides and PCBs, TPH-ext, TPH-purg, Metals TDS	Analytes will be determined based on results of grab groundwater sampling; this list includes the complete suite of analyses Obtain TDS data for beneficial use analysis
	IR75MW09 (new well if necessary)	VOCs, SVOCs, Pesticides and PCBs, TPH-ext, TPH-purg, Metals TDS	Analytes will be determined based on results of grab groundwater sampling; this list includes the complete suite of analyses Obtain TDS data for beneficial use analysis

TABLE 2.
PARCEL E WELLS FOR RESAMPLING
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CA
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IR Site	Monitoring Well	Target Analytes	Rationale for Resampling
IR-75 (A-aquifer) (cont.)	IR75MW09 (new well if necessary)	VOCs, SVOCs, Pesticides and PCBs, TPH-ext, TPH-purg, Metals	Analytes will be determined based on results of grab groundwater sampling; this list includes the complete suite of analyses
		TDS	Obtain TDS data for beneficial use analysis
	IR75MW09 (new well if necessary)	VOCs, SVOCs, Pesticides and PCBs, TPH-ext, TPH-purg, Metals	Analytes will be determined based on results of grab groundwater sampling; this list includes the complete suite of analyses
		TDS	Obtain TDS data for beneficial use analysis

Notes: New wells will be aded as listed if necessary, based on the results of direct-push technology grab groundwater sampling, as described in the "Revised Draft Final Data Gaps Sampling and Analysis Plan for Parcel E," dated October 4, 1999.

HVOC	Haolgenated volatile organic compound
IR	Installation Restoration
MCL	Maximum Contaminant Limit
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
SVOC	Semivolatile organic compound
TDS	Total dissolved solids
TPH-ext	Total petroleum hydrocarbons, extractables
TPH-purg	Total petroleum hydrocarbons, purgeables
VOC	Volatile organic compound

TABLE 3
RESULTS FOR THOSE CHEMICALS AND MONITORING WELLS
WHERE GROUNDWATER SAMPLE RESULTS EXCEED MCL SCREENING CRITERIA IN AT LEAST ONE SAMPLE
PARCEL E DATA GAP EVALUATION
HUNTERS POINT SHIPYARD
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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-01 (A-aquifer)	IR01MW03A	Aluminum	5/7/1991	16.3	U	16.3	ORIG	1000
		Aluminum	1/10/1992	17.2	U	17.2	ORIG	1000
		Aluminum	8/17/1992	21.6	U	21.6	ORIG	1000
		Aluminum	8/17/1992	1870		21.6	FDUP	1000
		Lead	5/7/1991	2.1	U	2.1	ORIG	14.44
		Lead	1/10/1992	1.2		1	ORIG	14.44
		Lead	8/17/1992	1.6	U	1.6	ORIG	14.44
		Lead	8/17/1992	24.4		1.6	FDUP	14.44
		Aroclor-1260	5/7/1991	5	U	5	ORIG	0.5
		Aroclor-1260	1/10/1992	1	U	1	ORIG	0.5
		Aroclor-1260	8/17/1992	1		1	ORIG	0.5
		Aroclor-1260	8/17/1992	1		1	FDUP	0.5
		1,4-Dichlorobenzene	5/7/1991	7		10	ORIG	5
		1,4-Dichlorobenzene	1/10/1992	7		10	ORIG	5
		1,4-Dichlorobenzene	8/17/1992	5		10	ORIG	5
		1,4-Dichlorobenzene	8/17/1992	7		10	FDUP	5
		Benzene	5/7/1991	5	U	5	ORIG	1
		Benzene	1/10/1992	2		5	ORIG	1
		Benzene	8/17/1992	5	U	5	ORIG	1
		Benzene	8/17/1992	1		5	FDUP	1
	IR01MW05A	Aluminum	5/5/1992	15.3		15.2	ORIG	1000
		Aluminum	5/5/1992	19.3		15.2	FDUP	1000
		Aluminum	7/23/1992	15100		21.6	ORIG	1000
		Aluminum	8/17/1992	21.6	U	21.6	ORIG	1000
		Aluminum	7/26/1995	38.3		16.3	ORIG	1000
		Antimony	5/5/1992	37.3		15.4	ORIG	43.26
		Antimony	5/5/1992	40.5		15.4	FDUP	43.26
		Antimony	7/23/1992	286		31.1	ORIG	43.26
		Antimony	8/17/1992	31.1	U	31.1	ORIG	43.26
		Antimony	7/26/1995	5.6	U	5.6	ORIG	43.26
		Cadmium	5/5/1992	1.7	U	1.7	ORIG	5.08
		Cadmium	5/5/1992	1.7	U	1.7	FDUP	5.08
		Cadmium	7/23/1992	20.2		2.7	ORIG	5.08
		Cadmium	8/17/1992	2.7	U	2.7	ORIG	5.08
		Cadmium	7/26/1995	0.2	U	0.2	ORIG	5.08
		Chromium	5/5/1992	2.9	U	2.9	ORIG	50
		Chromium	5/5/1992	4		2.9	FDUP	50
		Chromium	7/23/1992	647		2.5	ORIG	50
		Chromium	8/17/1992	4.4		2.5	ORIG	50
		Chromium	7/26/1995	8.3		1.8	ORIG	50
		Lead	5/5/1992	2.6	U	2.6	ORIG	14.44
		Lead	5/5/1992	2.9	U	2.9	FDUP	14.44
		Lead	7/23/1992	1960		80	ORIG	14.44
		Lead	8/17/1992	1.6	U	1.6	ORIG	14.44
		Lead	7/26/1995	2.5		1.5	ORIG	14.44
		Mercury	5/5/1992	0.59	J	0.1	ORIG	0.6
		Mercury	5/5/1992	0.2	J	0.1	FDUP	0.6
		Mercury	7/23/1992	4.6		0.4	ORIG	0.6
		Mercury	8/17/1992	0.2	U	0.2	ORIG	0.6
		Mercury	7/26/1995	0.1	U	0.1	ORIG	0.6
		Nickel	5/5/1992	157		8.7	ORIG	96.48
		Nickel	5/5/1992	163		8.7	FDUP	96.48
		Nickel	7/23/1992	780		17.3	ORIG	96.48
		Nickel	8/17/1992	68.2		17.3	ORIG	96.48
		Nickel	7/26/1995	118		3.3	ORIG	96.48
		Aroclor-1242	5/5/1992	0.5	U	0.5	ORIG	0.5
		Aroclor-1242	5/5/1992	0.5	U	0.5	FDUP	0.5
		Aroclor-1242	7/23/1992	38		10	ORIG	0.5
		Aroclor-1242	8/17/1992	10		5	ORIG	0.5
		Aroclor-1260	5/5/1992	2	J	1	ORIG	0.5
		Aroclor-1260	5/5/1992	3	J	1	FDUP	0.5
		Aroclor-1260	7/23/1992	36		20	ORIG	0.5
		Aroclor-1260	8/17/1992	7		10	ORIG	0.5

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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-01 (A-aquifer) (cont)	IR01MW05A (cont)	Benzene	5/5/1992	5	U	5	ORIG	1
		Benzene	5/5/1992	5	U	5	FDUP	1
		Benzene	7/23/1992	2		5	ORIG	1
		Benzene	8/17/1992	1		5	ORIG	1
	IR01MW16A	Aluminum	5/5/1992	56.7		15.2	ORIG	1000
		Aluminum	7/22/1992	27.4	U	27.4	ORIG	1000
		Aluminum	7/22/1992	2080		21.6	FDUP	1000
		Aluminum	8/18/1992	34.9	U	34.9	ORIG	1000
		Lead	5/5/1992	8.3	U	8.3	ORIG	14.44
		Lead	7/22/1992	1.6	U	1.6	ORIG	14.44
		Lead	7/22/1992	358		23.6	FDUP	14.44
		Lead	8/18/1992	1.6	U	1.6	ORIG	14.44
		Aroclor-1242	5/5/1992	0.5	U	0.5	ORIG	0.5
		Aroclor-1242	7/22/1992	28		12	ORIG	0.5
		Aroclor-1242	7/22/1992	52		12	FDUP	0.5
		Aroclor-1242	8/18/1992	30		5	ORIG	0.5
		Benzene	5/5/1992	4		10	ORIG	1
		Benzene	7/22/1992	4		5	ORIG	1
		Benzene	7/22/1992	4		5	FDUP	1
		Benzene	8/18/1992	4		5	ORIG	1
	IR01MW18A	Aluminum	5/6/1992	31.8		15.2	ORIG	1000
		Aluminum	5/6/1992	39.5		15.2	ORIG	1000
		Aluminum	5/6/1992	36.9		15.2	FDUP	1000
		Aluminum	7/23/1992	15200		21.6	ORIG	1000
		Aluminum	7/23/1992	21.6	U	21.6	FDUP	1000
		Aluminum	8/18/1992	270		21.6	ORIG	1000
		Chromium	5/6/1992	10		2.9	ORIG	50
		Chromium	5/6/1992	9.4		2.9	ORIG	50
		Chromium	5/6/1992	10.8		2.9	FDUP	50
		Chromium	7/23/1992	299		2.5	ORIG	50
		Chromium	7/23/1992	15		2.5	FDUP	50
		Chromium	8/18/1992	25.3		2.5	ORIG	50
		Lead	5/6/1992	1.2	U	1.2	ORIG	14.44
		Lead	5/6/1992	1.9	U	1.9	ORIG	14.44
		Lead	5/6/1992	1.5	U	1.5	FDUP	14.44
		Lead	7/23/1992	666		32	ORIG	14.44
		Lead	7/23/1992	1.6	U	1.6	FDUP	14.44
		Lead	8/18/1992	10.6		1.6	ORIG	14.44
		Mercury	5/6/1992	0.14	UJ	0.14	ORIG	0.6
		Mercury	5/6/1992	0.29	J	0.1	ORIG	0.6
		Mercury	5/6/1992	0.14	UJ	0.14	FDUP	0.6
		Mercury	7/23/1992	2.2		0.2	ORIG	0.6
		Mercury	7/23/1992	0.2	U	0.2	FDUP	0.6
		Mercury	8/18/1992	0.2	U	0.2	ORIG	0.6
		Nickel	5/6/1992	110		8.7	ORIG	96.48
		Nickel	5/6/1992	113		8.7	ORIG	96.48
		Nickel	5/6/1992	103		8.7	FDUP	96.48
		Nickel	7/23/1992	762		17.3	ORIG	96.48
		Nickel	7/23/1992	54.9		17.3	FDUP	96.48
		Nickel	8/18/1992	47.5		17.3	ORIG	96.48
		Aroclor-1242	5/6/1992	0.5	U	0.5	ORIG	0.5
		Aroclor-1242	5/6/1992	0.5	U	0.5	FDUP	0.5
		Aroclor-1242	7/23/1992	3	U	3	ORIG	0.5
		Aroclor-1242	7/23/1992	9		3	FDUP	0.5
		Aroclor-1242	8/18/1992	3	U	3	ORIG	0.5
		Benzene	5/6/1992	7		5	ORIG	1
		Benzene	5/6/1992	7		5	FDUP	1
		Benzene	7/23/1992	6		5	ORIG	1
		Benzene	7/23/1992	6		5	FDUP	1
		Benzene	8/18/1992	7		5	ORIG	1
	IR01MW31A	Aluminum	5/8/1992	20	U	20	ORIG	1000
		Aluminum	5/8/1992	20	U	20	FDUP	1000
		Aluminum	7/22/1992	42.3	U	42.3	ORIG	1000

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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-01 (A-aquifer) (cont)	IR01MW31A (cont.)	Aluminum	8/19/1992	2720		21.6	ORIG	1000
		Aluminum	8/19/1992	1960		21.6	FDUP	1000
		Aluminum	5/8/1992	0.8	U	0.8	ORIG	14.44
		Lead	5/8/1992	0.9	U	0.9	FDUP	14.44
		Lead	7/22/1992	1.6	U	1.6	ORIG	14.44
		Lead	8/19/1992	27.1		1.6	ORIG	14.44
		Lead	8/19/1992	22.5		1.6	FDUP	14.44
		Aroclor-1242	5/8/1992	2		0.5	ORIG	0.5
		Aroclor-1242	5/8/1992	5		3	FDUP	0.5
		Aroclor-1242	7/22/1992	3	U	3	ORIG	0.5
		Aroclor-1260	5/8/1992	0.8		1	ORIG	0.5
		Aroclor-1260	5/8/1992	2		5	FDUP	0.5
		Aroclor-1260	7/22/1992	5	U	5	ORIG	0.5
		Benzene	5/8/1992	3		5	ORIG	1
		Benzene	5/8/1992	3		5	FDUP	1
		Benzene	7/22/1992	2		5	ORIG	1
		Benzene	8/19/1992	1		5	ORIG	1
		Benzene	8/19/1992	1		5	FDUP	1
		Tetrachloroethene	5/8/1992	6		5	ORIG	5
		Tetrachloroethene	5/8/1992	5	U	5	FDUP	5
		Tetrachloroethene	7/22/1992	5	U	5	ORIG	5
		Tetrachloroethene	8/19/1992	5	U	5	ORIG	5
		Tetrachloroethene	8/19/1992	5	U	5	FDUP	5
	IR01MW366A	Cadmium	12/13/1995	0.2	U	0.2	ORIG	5.08
		Cadmium	3/6/1996	6.3		0.2	ORIG	5.08
		Cadmium	5/15/1996	4.1	U	4.1	ORIG	5.08
		Mercury	12/13/1995	0.5	U	0.5	ORIG	0.6
		Mercury	3/6/1996	5.3		0.1	ORIG	0.6
		Mercury	5/15/1996	1.9		0.1	ORIG	0.6
		Nickel	12/13/1995	19.3		1.3	ORIG	96.48
		Nickel	3/6/1996	101		0.7	ORIG	96.48
		Nickel	5/15/1996	38		0.9	ORIG	96.48
		Pentachlorophenol	12/4/1995	25	U	25	ORIG	1
		Pentachlorophenol	3/6/1996	6	J	25	ORIG	1
		Pentachlorophenol	5/15/1996	2	J	25	ORIG	1
	IR01MW367A	Benzene	11/27/1995	0.3	J	0.5	ORIG	1
		Benzene	3/5/1996	2	J	0.5	ORIG	1
		Benzene	5/14/1996	3		0.5	ORIG	1
	IR01MW38A	Benzene	5/7/1991	44		5	ORIG	1
		Benzene	1/16/1992	10	U	10	ORIG	1
		Benzene	1/16/1992	1		5	FDUP	1
		Benzene	8/18/1992	1		5	ORIG	1
	IR01MW400A	Aroclor-1242	9/12/1996	3		0.5	ORIG	0.5
		Aroclor-1242	10/15/1996	2		0.5	ORIG	0.5
		Aroclor-1242	10/15/1996	2		0.5	FDUP	0.5
		Aroclor-1242	11/14/1996	1		0.5	ORIG	0.5
		AROCLOR-1248	9/12/1996	2		0.5	ORIG	0.5
		AROCLOR-1248	10/15/1996	0.5	U	0.5	ORIG	0.5
		AROCLOR-1248	10/15/1996	0.5	U	0.5	FDUP	0.5
		AROCLOR-1248	11/14/1996	0.5	U	0.5	ORIG	0.5
	IR01MW42A	Lead	1/9/1992	91.8		1	ORIG	14.44
		Lead	1/9/1992	100		1	FDUP	14.44
		Lead	7/9/1992	3.4	U	3.4	ORIG	14.44
		Lead	8/18/1992	13.8		1.6	ORIG	14.44
	IR01MW43A	Antimony	3/22/1991	27.1		21.7	ORIG	43.26
		Antimony	1/9/1992	32	U	32	ORIG	43.26
		Antimony	8/18/1992	41.5		31.1	ORIG	43.26
		Antimony	8/18/1992	49.1		31.1	FDUP	43.26
		Antimony	3/19/1996	4.5	J	1.6	ORIG	43.26
		Aroclor-1260	3/22/1991	37		10	ORIG	0.5
		Aroclor-1260	1/9/1992	1	U	1	ORIG	0.5
		Aroclor-1260	8/18/1992	32	J	50	ORIG	0.5
		Aroclor-1260	8/18/1992	50	U	50	FDUP	0.5

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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-01 (A-aquifer) (cont)	IR01MW43A (cont.)	Aroclor-1260	3/19/1996	3	J	0.5	ORIG	0.5
		1,4-Dichlorobenzene	3/22/1991	16	J	10	ORIG	5
		1,4-Dichlorobenzene	1/9/1992	8		10	ORIG	5
		1,4-Dichlorobenzene	8/18/1992	11		10	ORIG	5
		1,4-Dichlorobenzene	8/18/1992	13		10	FDUP	5
		1,4-Dichlorobenzene	3/19/1996	8		5	ORIG	5
		1,1-Dichloroethane	3/22/1991	12		5	ORIG	5
		1,1-Dichloroethane	1/9/1992	25	U	25	ORIG	5
		1,1-Dichloroethane	8/18/1992	5	U	5	ORIG	5
		1,1-Dichloroethane	8/18/1992	5	U	5	FDUP	5
		1,1-Dichloroethane	3/19/1996	16		0.5	ORIG	5
		Benzene	3/22/1991	2		5	ORIG	1
		Benzene	1/9/1992	9		25	ORIG	1
		Benzene	8/18/1992	14		5	ORIG	1
		Benzene	8/18/1992	12		5	FDUP	1
		Benzene	3/19/1996	5		0.5	ORIG	1
	IR01MW44A	Aroclor-1260	3/25/1991	20	J	10	ORIG	0.5
		Aroclor-1260	3/25/1991	34		10	FDUP	0.5
		Aroclor-1260	1/20/1992	13		10	ORIG	0.5
		Aroclor-1260	8/20/1992	10	U	10	ORIG	0.5
		Aroclor-1260	8/20/1992	19		20	FDUP	0.5
		Aroclor-1260	3/19/1996	3		0.5	ORIG	0.5
		Heptachlor	3/25/1991	0.5	U	0.5	ORIG	0.0036
		Heptachlor	3/25/1991	0.5	U	0.5	FDUP	0.0036
		Heptachlor	1/20/1992	0.5	U	0.5	ORIG	0.0036
		Heptachlor	8/20/1992	0.5	U	0.5	ORIG	0.0036
		Heptachlor	8/20/1992	0.5	U	0.5	FDUP	0.0036
		Heptachlor	3/19/1996	0.01	J	0.05	ORIG	0.0036
	IR01MW48A	Aluminum	1/22/1992	20	U	20	ORIG	1000
		Aluminum	1/22/1992	20	U	20	FDUP	1000
		Aluminum	7/9/1992	4190	J	21.6	ORIG	1000
		Aluminum	8/19/1992	21.6	U	21.6	ORIG	1000
		Barium	1/22/1992	1880		0.5	ORIG	1000
		Barium	1/22/1992	1820		0.5	FDUP	1000
		Barium	7/9/1992	1200		0.6	ORIG	1000
		Barium	8/19/1992	1310		0.6	ORIG	1000
		Chromium	1/22/1992	2.7	U	2.7	ORIG	50
		Chromium	1/22/1992	2.7	U	2.7	FDUP	50
		Chromium	7/9/1992	56.2		2.5	ORIG	50
		Chromium	8/19/1992	2.5	U	2.5	ORIG	50
		Lead	1/22/1992	1		0.8	ORIG	14.44
		Lead	1/22/1992	1		0.8	FDUP	14.44
		Lead	7/9/1992	61.2		1.6	ORIG	14.44
		Lead	8/19/1992	1.6	U	1.6	ORIG	14.44
		Benzene	1/22/1992	3		5	ORIG	1
		Benzene	1/22/1992	3		5	FDUP	1
		Benzene	7/9/1992	3		5	ORIG	1
		Benzene	8/19/1992	4		5	ORIG	1
	IR01MW58A	Barium	3/25/1991	1990		0.31	ORIG	1000
		Barium	1/20/1992	2610		0.5	ORIG	1000
		Barium	1/20/1992	2390		0.5	FDUP	1000
		Barium	8/20/1992	2140		0.6	ORIG	1000
		Benzene	3/25/1991	1		5	ORIG	1
		Benzene	1/20/1992	5		5	ORIG	1
		Benzene	1/20/1992	6		25	FDUP	1
		Benzene	8/20/1992	6		5	ORIG	1
	IR01MW62A	Aluminum	1/21/1992	20	U	20	ORIG	1000
		Aluminum	1/21/1992	20	U	20	FDUP	1000
		Aluminum	7/21/1992	53300		21.6	ORIG	1000
		Aluminum	8/20/1992	45.2	U	45.2	ORIG	1000
		Antimony	1/21/1992	27.5		26.3	ORIG	43.26
		Antimony	1/21/1992	31.9		26.3	FDUP	43.26
		Antimony	7/21/1992	46.9		31.1	ORIG	43.26

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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-01 (A-aquifer) (cont)	IR01MW62A (cont.)	Antimony	8/20/1992	31.1	U	31.1	ORIG	43.26
		Arsenic	1/21/1992	2.7		1.7	ORIG	36
		Arsenic	1/21/1992	1.9		1.7	FDUP	36
		Arsenic	7/21/1992	69.6	J	4	ORIG	36
		Arsenic	8/20/1992	2.8		2	ORIG	36
		Barium	1/21/1992	4260		0.5	ORIG	1000
		Barium	1/21/1992	3850		0.5	FDUP	1000
		Barium	7/21/1992	7480		0.6	ORIG	1000
		Barium	8/20/1992	6350		0.6	ORIG	1000
		Cadmium	1/21/1992	2.8	U	2.8	ORIG	5.08
		Cadmium	1/21/1992	2.8	U	2.8	FDUP	5.08
		Cadmium	7/21/1992	11.1		2.7	ORIG	5.08
		Cadmium	8/20/1992	2.7	U	2.7	ORIG	5.08
		Chromium	1/21/1992	2.7	U	2.7	ORIG	50
		Chromium	1/21/1992	2.7	U	2.7	FDUP	50
		Chromium	7/21/1992	459		2.5	ORIG	50
		Chromium	8/20/1992	2.5	U	2.5	ORIG	50
		Lead	1/21/1992	0.9		0.8	ORIG	14.44
		Lead	1/21/1992	0.9		0.8	FDUP	14.44
		Lead	7/21/1992	3740		23.6	ORIG	14.44
		Lead	8/20/1992	1.6	U	1.6	ORIG	14.44
		Mercury	1/21/1992	0.2	U	0.2	ORIG	0.6
		Mercury	1/21/1992	0.2	U	0.2	FDUP	0.6
		Mercury	7/21/1992	4.4		0.2	ORIG	0.6
		Mercury	8/20/1992	0.2	U	0.2	ORIG	0.6
		Nickel	1/21/1992	33.6		28.8	ORIG	96.48
		Nickel	1/21/1992	28.8	U	28.8	FDUP	96.48
		Nickel	7/21/1992	740		17.3	ORIG	96.48
		Nickel	8/20/1992	17.3	U	17.3	ORIG	96.48
		Benzo(a)pyrene	1/21/1992	20	U	20	ORIG	0.2
		Benzo(a)pyrene	1/21/1992	10	U	10	FDUP	0.2
		Benzo(a)pyrene	7/21/1992	10	UJ	10	ORIG	0.2
		Benzo(a)pyrene	8/20/1992	2		10	ORIG	0.2
	IR01MW63A	Barium	1/22/1992	825		0.5	ORIG	1000
		Barium	7/20/1992	1080		0.6	ORIG	1000
		Barium	7/20/1992	1080		0.6	FDUP	1000
		Barium	8/20/1992	933		0.6	ORIG	1000
	IR01MWI-2	Aluminum	1/9/1992	18.4	U	18.4	ORIG	1000
		Aluminum	7/6/1992	183000	J	21.6	ORIG	1000
		Aluminum	8/21/1992	21.6	U	21.6	ORIG	1000
		Arsenic	1/9/1992	15.5		1	ORIG	36
		Arsenic	7/6/1992	77.8		4	ORIG	36
		Arsenic	8/21/1992	15.5		2	ORIG	36
		Barium	1/9/1992	270		2	ORIG	1000
		Barium	7/6/1992	1500	J	0.6	ORIG	1000
		Barium	8/21/1992	234		0.6	ORIG	1000
		Beryllium	1/9/1992	1	U	1	ORIG	4
		Beryllium	7/6/1992	5.1		0.5	ORIG	4
		Beryllium	8/21/1992	0.5	U	0.5	ORIG	4
		Chromium	1/9/1992	5	U	5	ORIG	50
		Chromium	7/6/1992	2750	J	2.5	ORIG	50
		Chromium	8/21/1992	2.5	U	2.5	ORIG	50
		Lead	1/9/1992	1	U	1	ORIG	14.44
		Lead	7/6/1992	128		8	ORIG	14.44
		Lead	8/21/1992	1.6	U	1.6	ORIG	14.44
		Nickel	1/9/1992	119	J	17	ORIG	96.48
		Nickel	7/6/1992	6260	J	17.3	ORIG	96.48
		Nickel	8/21/1992	111		17.3	ORIG	96.48
	IR01MWI-3	Nickel	1/16/1992	28.4		17	ORIG	96.48
		Nickel	7/6/1992	80.7	J	17.3	ORIG	96.48
		Nickel	7/6/1992	87	J	17.3	FDUP	96.48
		Nickel	8/24/1992	63		17.3	ORIG	96.48
		Nickel	3/19/1996	315		0.7	ORIG	96.48

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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-01 (A-aquifer) (cont.)	IR01MWI-3 (cont.)	Aroclor-1260	1/16/1992	11		10	ORIG	0.5
		Aroclor-1260	7/6/1992	54		25	ORIG	0.5
		Aroclor-1260	7/6/1992	6		5	FDUP	0.5
		Aroclor-1260	8/24/1992	11		10	ORIG	0.5
		Aroclor-1260	3/19/1996	2		0.5	ORIG	0.5
		1,4-Dichlorobenzene	1/16/1992	5		10	ORIG	5
		1,4-Dichlorobenzene	7/6/1992	7		10	ORIG	5
		1,4-Dichlorobenzene	7/6/1992	7		10	FDUP	5
		1,4-Dichlorobenzene	8/24/1992	7		10	ORIG	5
		1,4-Dichlorobenzene	3/19/1996	50	U	50	ORIG	5
		Benzo(a)pyrene	1/16/1992	10	U	10	ORIG	0.2
		Benzo(a)pyrene	7/6/1992	2		10	ORIG	0.2
		Benzo(a)pyrene	7/6/1992	2		10	FDUP	0.2
		Benzo(a)pyrene	8/24/1992	3		10	ORIG	0.2
		Benzo(a)pyrene	3/19/1996	100	U	100	ORIG	0.2
		Benzene	1/16/1992	6		25	ORIG	1
		Benzene	7/6/1992	5		5	ORIG	1
		Benzene	7/6/1992	5		5	FDUP	1
		Benzene	8/24/1992	9		5	ORIG	1
		Benzene	3/19/1996	8		0.5	ORIG	1
	IR01MWI-5	Aluminum	1/16/1992	20.8	U	20.8	ORIG	1000
		Aluminum	7/9/1992	24700	J	21.6	ORIG	1000
		Aluminum	7/9/1992	17900	J	21.6	FDUP	1000
		Aluminum	8/21/1992	21.6	U	21.6	ORIG	1000
		Antimony	1/16/1992	32	U	32	ORIG	43.26
		Antimony	7/9/1992	74.2		31.1	ORIG	43.26
		Antimony	7/9/1992	78.7		31.1	FDUP	43.26
		Antimony	8/21/1992	31.1	U	31.1	ORIG	43.26
		Barium	1/16/1992	756		2	ORIG	1000
		Barium	7/9/1992	1120		0.6	ORIG	1000
		Barium	7/9/1992	1050		0.6	FDUP	1000
		Barium	8/21/1992	903		0.6	ORIG	1000
		Chromium	1/16/1992	20.2	J	5	ORIG	50
		Chromium	7/9/1992	370		2.5	ORIG	50
		Chromium	7/9/1992	272		2.5	FDUP	50
		Chromium	8/21/1992	17.8		2.5	ORIG	50
		Copper	1/16/1992	2.3	UJ	2.3	ORIG	28.04
		Copper	7/9/1992	1780		1.8	ORIG	28.04
		Copper	7/9/1992	1260		1.8	FDUP	28.04
		Copper	8/21/1992	2	U	2	ORIG	28.04
		Lead	1/16/1992	1	U	1	ORIG	14.44
		Lead	7/9/1992	1430		80	ORIG	14.44
		Lead	7/9/1992	994		32	FDUP	14.44
		Lead	8/21/1992	1.6	U	1.6	ORIG	14.44
		Mercury	1/16/1992	0.2	U	0.2	ORIG	0.6
		Mercury	7/9/1992	6.5		0.2	ORIG	0.6
		Mercury	7/9/1992	4.6		0.2	FDUP	0.6
		Mercury	8/21/1992	0.2	U	0.2	ORIG	0.6
		Nickel	1/16/1992	33.9		17	ORIG	96.48
		Nickel	7/9/1992	476		17.3	ORIG	96.48
		Nickel	7/9/1992	366		17.3	FDUP	96.48
		Nickel	8/21/1992	60.4		17.3	ORIG	96.48
		Aroclor-1242	1/16/1992	5	U	5	ORIG	0.5
		Aroclor-1242	7/9/1992	25	U	25	ORIG	0.5
		Aroclor-1242	7/9/1992	5	U	5	FDUP	0.5
		Aroclor-1242	8/21/1992	17		5	ORIG	0.5
		Aroclor-1260	1/16/1992	10	U	10	ORIG	0.5
		Aroclor-1260	7/9/1992	50	U	50	ORIG	0.5
		Aroclor-1260	7/9/1992	10		10	FDUP	0.5
		Aroclor-1260	8/21/1992	16		10	ORIG	0.5
		Heptachlor	1/16/1992	0.5	U	0.5	ORIG	0.0036
		Heptachlor	7/9/1992	3	U	3	ORIG	0.0036
		Heptachlor	7/9/1992	0.5		0.5	FDUP	0.0036

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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-01	IR01MWI-5	Heptachlor	8/21/1992	0.5	U	0.5	ORIG	0.0036
(A-aquifer)	(cont.)	1,4-Dichlorobenzene	1/16/1992	4		10	ORIG	5
(cont.)		1,4-Dichlorobenzene	7/9/1992	8		10	ORIG	5
		1,4-Dichlorobenzene	7/9/1992	8		10	FDUP	5
		1,4-Dichlorobenzene	8/21/1992	10		40	ORIG	5
		Benzene	1/16/1992	25	U	25	ORIG	1
		Benzene	7/9/1992	3		5	ORIG	1
		Benzene	7/9/1992	3		5	FDUP	1
		Benzene	8/21/1992	5		5	ORIG	1
	IR01MWI-9	Aluminum	1/21/1992	20	U	20	ORIG	1000
		Aluminum	7/6/1992	91200	J	21.6	ORIG	1000
		Aluminum	8/21/1992	21.6	U	21.6	ORIG	1000
		Aluminum	8/21/1992	21.6	U	21.6	FDUP	1000
		Antimony	1/21/1992	26.3	U	26.3	ORIG	43.26
		Antimony	7/6/1992	62.9	J	31.1	ORIG	43.26
		Antimony	8/21/1992	31.1	U	31.1	ORIG	43.26
		Antimony	8/21/1992	31.1	U	31.1	FDUP	43.26
		Arsenic	1/21/1992	2.2		1.7	ORIG	36
		Arsenic	7/6/1992	61.6		2	ORIG	36
		Arsenic	8/21/1992	6.2		2	ORIG	36
		Arsenic	8/21/1992	6.5		2	FDUP	36
		Barium	1/21/1992	366		0.5	ORIG	1000
		Barium	7/6/1992	1720	J	0.6	ORIG	1000
		Barium	8/21/1992	246		0.6	ORIG	1000
		Barium	8/21/1992	245		0.6	FDUP	1000
		Cadmium	1/21/1992	2.8	U	2.8	ORIG	5.08
		Cadmium	7/6/1992	7		2.7	ORIG	5.08
		Cadmium	8/21/1992	2.7	U	2.7	ORIG	5.08
		Cadmium	8/21/1992	2.7	U	2.7	FDUP	5.08
		Chromium	1/21/1992	2.7	U	2.7	ORIG	50
		Chromium	7/6/1992	828	J	2.5	ORIG	50
		Chromium	8/21/1992	2.8		2.5	ORIG	50
		Chromium	8/21/1992	2.5	U	2.5	FDUP	50
		Lead	1/21/1992	1.2		0.8	ORIG	14.44
		Lead	7/6/1992	6520		320	ORIG	14.44
		Lead	8/21/1992	1.6	U	1.6	ORIG	14.44
		Lead	8/21/1992	1.6	U	1.6	FDUP	14.44
		Mercury	1/21/1992	0.2	U	0.2	ORIG	0.6
		Mercury	7/6/1992	10		1	ORIG	0.6
		Mercury	8/21/1992	0.2	U	0.2	ORIG	0.6
		Mercury	8/21/1992	0.2	U	0.2	FDUP	0.6
		Nickel	1/21/1992	28.8	U	28.8	ORIG	96.48
		Nickel	7/6/1992	1080	J	17.3	ORIG	96.48
		Nickel	8/21/1992	17.3	U	17.3	ORIG	96.48
		Nickel	8/21/1992	17.3	U	17.3	FDUP	96.48
		Aroclor-1242	1/21/1992	0.5	U	0.5	ORIG	0.5
		Aroclor-1242	7/6/1992	0.5	U	0.5	ORIG	0.5
		Aroclor-1242	8/21/1992	5	U	5	ORIG	0.5
		Aroclor-1242	8/21/1992	9		5	FDUP	0.5
		Aroclor-1260	1/21/1992	1	U	1	ORIG	0.5
		Aroclor-1260	7/6/1992	3		1	ORIG	0.5
		Aroclor-1260	8/21/1992	10	U	10	ORIG	0.5
		Aroclor-1260	8/21/1992	5		10	FDUP	0.5
		Benzo(a)pyrene	1/21/1992	10	U	10	ORIG	0.2
		Benzo(a)pyrene	7/6/1992	10	U	10	ORIG	0.2
		Benzo(a)pyrene	8/21/1992	10	U	10	ORIG	0.2
		Benzo(a)pyrene	8/21/1992	2		10	FDUP	0.2
IR-01	IR01MW02B	Aluminum	5/7/1991	16.3	U	16.3	ORIG	1000
(B-aquifer)		Aluminum	5/7/1991	16.3	U	16.3	FDUP	1000
		Aluminum	1/17/1992	16	U	16	ORIG	1000
		Aluminum	8/17/1992	3630		21.6	ORIG	1000
		Chromium	5/7/1991	56		1.4	ORIG	50
		Chromium	5/7/1991	58.3		1.4	FDUP	50

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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-01 (B-aquifer) (cont.)	IR01MW02B (cont.)	Chromium	1/17/1992	62.5		5	ORIG	50
		Chromium	8/17/1992	80		2.5	ORIG	50
	IR01MW17B	Aluminum	1/28/1992	20	U	20	ORIG	1000
		Aluminum	7/22/1992	21.6	U	21.6	ORIG	1000
		Aluminum	8/18/1992	4040		21.6	ORIG	1000
		Antimony	1/28/1992	26.3	U	26.3	ORIG	43.26
		Antimony	7/22/1992	96.3		31.1	ORIG	43.26
		Antimony	8/18/1992	31.1	U	31.1	ORIG	43.26
		Cadmium	1/28/1992	2.8	U	2.8	ORIG	5.08
		Cadmium	7/22/1992	7.6		2.7	ORIG	5.08
		Cadmium	8/18/1992	2.7	U	2.7	ORIG	5.08
		Bis(2-ethylhexyl)phthalate	1/28/1992	10	UJ	10	ORIG	6
		Bis(2-ethylhexyl)phthalate	7/22/1992	160		10	ORIG	6
		Bis(2-ethylhexyl)phthalate	8/18/1992	5	UJ	5	ORIG	6
	IR01MW47B	Carbon tetrachloride	1/27/1992	5	U	5	ORIG	0.5
		Carbon tetrachloride	7/20/1992	3		5	ORIG	0.5
		Carbon tetrachloride	8/20/1992	5	U	5	ORIG	0.5
	IR01MW53B	Cadmium	5/6/1991	2.7	U	2.7	ORIG	5.08
		Cadmium	1/22/1992	2.8	U	2.8	ORIG	5.08
		Cadmium	8/20/1992	8		2.7	ORIG	5.08
IR-02 (A-aquifer)	IR02MW101A1	Aluminum	1/7/1992	31.5	U	31.5	ORIG	1000
		Aluminum	1/7/1992	32.1	U	32.1	FDUP	1000
		Aluminum	7/8/1992	4450	J	21.6	ORIG	1000
		Aluminum	8/24/1992	42	U	42	ORIG	1000
		Chromium	1/7/1992	5	U	5	ORIG	50
		Chromium	1/7/1992	5	U	5	FDUP	50
		Chromium	7/8/1992	69		2.5	ORIG	50
		Chromium	8/24/1992	2.5	U	2.5	ORIG	50
		Nickel	1/7/1992	17	UJ	17	ORIG	96.48
		Nickel	1/7/1992	17	UJ	17	FDUP	96.48
		Nickel	7/8/1992	202		17.3	ORIG	96.48
		Nickel	8/24/1992	22.6		17.3	ORIG	96.48
		Pentachlorophenol	1/7/1992	50	U	50	ORIG	1
		Pentachlorophenol	1/7/1992	3		50	FDUP	1
		Pentachlorophenol	7/8/1992	50	U	50	ORIG	1
		Pentachlorophenol	8/24/1992	50	U	50	ORIG	1
	IR02MW101A2	Barium	1/8/1992	1760		2	ORIG	1000
		Barium	7/9/1992	1810		0.6	ORIG	1000
		Barium	8/25/1992	1950		0.6	ORIG	1000
		Cadmium	1/8/1992	4	U	4	ORIG	5.08
		Cadmium	7/9/1992	2.7	U	2.7	ORIG	5.08
		Cadmium	8/25/1992	14.7		2.7	ORIG	5.08
	IR02MW114A1	Cadmium	1/14/1992	4	U	4	ORIG	5.08
		Cadmium	7/7/1992	4.7		2.7	ORIG	5.08
		Cadmium	8/25/1992	15.8		2.7	ORIG	5.08
	IR02MW114A2	Aluminum	1/13/1992	16	U	16	ORIG	1000
		Aluminum	7/10/1992	16200	J	21.6	ORIG	1000
		Aluminum	8/25/1992	21.6	U	21.6	ORIG	1000
		Cadmium	1/13/1992	4	U	4	ORIG	5.08
		Cadmium	7/10/1992	2.7	U	2.7	ORIG	5.08
		Cadmium	8/25/1992	8.1		2.7	ORIG	5.08
		Chromium	1/13/1992	5	U	5	ORIG	50
		Chromium	7/10/1992	148		2.5	ORIG	50
		Chromium	8/25/1992	2.5	U	2.5	ORIG	50
		Nickel	1/13/1992	18.6	J	17	ORIG	96.48
		Nickel	7/10/1992	267		17.3	ORIG	96.48
		Nickel	8/25/1992	22.2		17.3	ORIG	96.48
	IR02MW114A3	Barium	1/14/1992	972		2	ORIG	1000
		Barium	7/8/1992	1050	J	0.6	ORIG	1000
		Barium	8/26/1992	1120		0.6	ORIG	1000
		Cadmium	1/14/1992	4	U	4	ORIG	5.08
		Cadmium	7/8/1992	7.3		2.7	ORIG	5.08
		Cadmium	8/26/1992	37.9		2.7	ORIG	5.08

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IR Site	Station	Analyte	Sample Date	Result (μg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-02 (A-aquifer) (cont.)	IR02MW126A	Barium	1/6/1992	1020		2	ORIG	1000
		Barium	7/8/1992	436		0.6	ORIG	1000
		Barium	7/8/1992	858		0.6	FDUP	1000
		Barium	8/25/1992	524		0.6	ORIG	1000
		Lead	1/6/1992	1	UJ	1	ORIG	14.44
		Lead	7/8/1992	1.6	U	1.6	ORIG	14.44
		Lead	7/8/1992	26.7		1.6	FDUP	14.44
		Lead	8/25/1992	1.7		1.6	ORIG	14.44
		Aroclor-1260	1/6/1992	3		1	ORIG	0.5
		Aroclor-1260	7/8/1992	4		5	ORIG	0.5
		Aroclor-1260	7/8/1992	4		5	FDUP	0.5
		Aroclor-1260	8/25/1992	3	J	5	ORIG	0.5
	IR02MW141A	Aluminum	5/7/1992	20	U	20	ORIG	1000
		Aluminum	5/7/1992	20	U	20	FDUP	1000
		Aluminum	7/21/1992	21100		21.6	ORIG	1000
		Aluminum	7/21/1992	22600		21.6	FDUP	1000
		Aluminum	8/25/1992	21.6	U	21.6	ORIG	1000
		Aluminum	8/25/1992	21.6	U	21.6	FDUP	1000
		Antimony	5/7/1992	47.8		26.3	ORIG	43.26
		Antimony	5/7/1992	62.6		26.3	FDUP	43.26
		Antimony	7/21/1992	757		31.1	ORIG	43.26
		Antimony	7/21/1992	771		31.1	FDUP	43.26
		Antimony	8/25/1992	31.1	U	31.1	ORIG	43.26
		Antimony	8/25/1992	31.1	U	31.1	FDUP	43.26
		Barium	5/7/1992	81.7		0.5	ORIG	1000
		Barium	5/7/1992	82		0.5	FDUP	1000
		Barium	7/21/1992	1270		0.6	ORIG	1000
		Barium	7/21/1992	1220		0.6	FDUP	1000
		Barium	8/25/1992	74.6		0.6	ORIG	1000
		Barium	8/25/1992	71.2		0.6	FDUP	1000
		Cadmium	5/7/1992	2.8	U	2.8	ORIG	5.08
		Cadmium	5/7/1992	2.8	U	2.8	FDUP	5.08
		Cadmium	7/21/1992	113		2.7	ORIG	5.08
		Cadmium	7/21/1992	110		2.7	FDUP	5.08
		Cadmium	8/25/1992	3.6		2.7	ORIG	5.08
		Cadmium	8/25/1992	3.3		2.7	FDUP	5.08
		Chromium	5/7/1992	2.7	U	2.7	ORIG	50
		Chromium	5/7/1992	2.7	U	2.7	FDUP	50
		Chromium	7/21/1992	491		2.5	ORIG	50
		Chromium	7/21/1992	517		2.5	FDUP	50
		Chromium	8/25/1992	2.5	U	2.5	ORIG	50
		Chromium	8/25/1992	2.5	U	2.5	FDUP	50
		Copper	5/7/1992	14.6	U	14.6	ORIG	28.04
		Copper	5/7/1992	20	U	20	FDUP	28.04
		Copper	7/21/1992	17800	J	1.8	ORIG	28.04
		Copper	7/21/1992	19800	J	1.8	FDUP	28.04
		Copper	8/25/1992	36.2		1.8	ORIG	28.04
		Copper	8/25/1992	28		1.8	FDUP	28.04
		Lead	5/7/1992	6.4	U	6.4	ORIG	14.44
		Lead	5/7/1992	7.9	U	7.9	FDUP	14.44
		Lead	7/21/1992	9790		23.6	ORIG	14.44
		Lead	7/21/1992	10200		23.6	FDUP	14.44
		Lead	8/25/1992	6.4		1.6	ORIG	14.44
		Lead	8/25/1992	5.6		1.6	FDUP	14.44
		Mercury	5/7/1992	0.2	U	0.2	ORIG	0.6
		Mercury	5/7/1992	0.2	U	0.2	FDUP	0.6
		Mercury	7/21/1992	54		4	ORIG	0.6
		Mercury	7/21/1992	44		4	FDUP	0.6
		Mercury	8/25/1992	0.2	U	0.2	ORIG	0.6
		Mercury	8/25/1992	0.2	U	0.2	FDUP	0.6
		Nickel	5/7/1992	35.8		28.8	ORIG	96.48
		Nickel	5/7/1992	34.6		28.8	FDUP	96.48
		Nickel	7/21/1992	1450		17.3	ORIG	96.48

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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-02 (A-aquifer) (cont.)	IR02MW141A (cont.)	Nickel	7/21/1992	1450		17.3	FDUP	96.48
		Nickel	8/25/1992	32		17.3	ORIG	96.48
		Nickel	8/25/1992	42.2		17.3	FDUP	96.48
		Aroclor-1242	5/7/1992	3	U	3	ORIG	0.5
		Aroclor-1242	5/7/1992	2		0.5	FDUP	0.5
		Aroclor-1242	7/21/1992	0.5	U	0.5	ORIG	0.5
		Aroclor-1242	7/21/1992	0.5	U	0.5	FDUP	0.5
		Aroclor-1242	8/25/1992	0.5	U	0.5	ORIG	0.5
		Aroclor-1242	8/25/1992	0.5	U	0.5	FDUP	0.5
		Aroclor-1260	5/7/1992	2		5	ORIG	0.5
		Aroclor-1260	5/7/1992	0.9		1	FDUP	0.5
		Aroclor-1260	7/21/1992	0.7		1	ORIG	0.5
		Aroclor-1260	7/21/1992	0.7		1	FDUP	0.5
		Aroclor-1260	8/25/1992	5	J	1	ORIG	0.5
		Aroclor-1260	8/25/1992	3	J	1	FDUP	0.5
	IR02MW146A	Aroclor-1260	1/30/1992	1	U	1	ORIG	0.5
		Aroclor-1260	1/30/1992	9		5	FDUP	0.5
		Aroclor-1260	3/26/1996	0.5	U	0.5	ORIG	0.5
		Aroclor-1260	5/29/1996	0.5	U	0.5	ORIG	0.5
		Aroclor-1260	5/29/1996	0.5	U	0.5	FDUP	0.5
		Benzene	1/30/1992	3		5	ORIG	1
		Benzene	1/30/1992	2		5	FDUP	1
		Benzene	3/26/1996	3		0.5	ORIG	1
		Benzene	5/29/1996	2		0.5	ORIG	1
		Benzene	5/29/1996	2		0.5	FDUP	1
	IR02MW147A	Pentachlorophenol	1/15/1992	2	J	50	ORIG	1
	IR02MW173A	Arsenic	1/29/1992	54.6		1.7	ORIG	36
		Arsenic	1/29/1992	49.6		1.7	FDUP	36
		Arsenic	3/26/1996	75.7		1.4	ORIG	36
		Arsenic	5/30/1996	73.7		1.3	ORIG	36
		Barium	1/29/1992	4250		0.5	ORIG	1000
		Barium	1/29/1992	4110		0.5	FDUP	1000
		Barium	3/26/1996	2880		0.3	ORIG	1000
		Barium	5/30/1996	2720	J	0.8	ORIG	1000
		Benzene	1/29/1992	2		5	ORIG	1
		Benzene	1/29/1992	2		5	FDUP	1
		Benzene	3/26/1996	1		0.5	ORIG	1
		Benzene	5/30/1996	0.8		0.5	ORIG	1
	IR02MW175A	Aluminum	1/14/1992	22.4	U	22.4	ORIG	1000
		Aluminum	7/10/1992	1710	J	21.6	ORIG	1000
		Aluminum	7/10/1992	664	J	21.6	FDUP	1000
		Aluminum	8/25/1992	21.6	U	21.6	ORIG	1000
		1,2-Dichloroethene	1/14/1992	5	U	5	ORIG	0.5
		1,2-Dichloroethene	7/10/1992	5	U	5	ORIG	0.5
		1,2-Dichloroethene	7/10/1992	1		5	FDUP	0.5
		1,2-Dichloroethene	8/25/1992	5	U	5	ORIG	0.5
		Tetrachloroethene	1/14/1992	5	U	5	ORIG	5
		Tetrachloroethene	7/10/1992	5	U	5	ORIG	5
		Tetrachloroethene	7/10/1992	6		5	FDUP	5
		Tetrachloroethene	8/25/1992	5	U	5	ORIG	5
	IR02MW179A	Cadmium	1/14/1992	4	U	4	ORIG	5.08
		Cadmium	6/9/1992	2.7	U	2.7	ORIG	5.08
		Cadmium	8/25/1992	8.4		2.7	ORIG	5.08
	IR02MW183A	Pentachlorophenol	1/14/1992	33		50	ORIG	1
		Pentachlorophenol	6/9/1992	50	U	50	ORIG	1
		Pentachlorophenol	8/26/1992	50	U	50	ORIG	1
	IR02MW298A	Aluminum	7/8/1992	7510	J	21.6	ORIG	1000
		Aluminum	8/27/1992	21.6	U	21.6	ORIG	1000
		Aluminum	3/22/1996	49.3	U	49.3	ORIG	1000
		Chromium	7/8/1992	70.6	J	2.5	ORIG	50
		Chromium	8/27/1992	2.5	U	2.5	ORIG	50
		Chromium	3/22/1996	0.65	U	0.65	ORIG	50
		Nickel	7/8/1992	200	J	17.3	ORIG	96.48

TABLE 3
RESULTS FOR THOSE CHEMICALS AND MONITORING WELLS
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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-02 (A-aquifer) (cont.)	IR02MW298A (cont.)	Nickel	8/27/1992	41.6		17.3	ORIG	96.48
		Nickel	3/22/1996	23.1		0.7	ORIG	96.48
	IR02MW299A	1,2-Dichloroethene	7/6/1992	5	U	5	ORIG	0.5
		1,2-Dichloroethene	8/26/1992	1		5	ORIG	0.5
		1,2-Dichloroethene	3/21/1996	0.5	U	0.5	ORIG	0.5
	IR02MW372A	Heptachlor epoxide	11/22/1995	0.01	U	0.01	ORIG	0.01
		Heptachlor epoxide	3/7/1996	0.2		0.01	ORIG	0.01
		Heptachlor epoxide	5/10/1996	0.2		0.1	ORIG	0.01
		Benzene	11/22/1995	5		0.5	ORIG	1
		Benzene	3/7/1996	2	J	0.5	ORIG	1
		Benzene	5/10/1996	3		0.5	ORIG	1
		Vinyl chloride	11/22/1995	0.7	J	0.5	ORIG	0.5
		Vinyl chloride	3/7/1996	0.7		0.5	ORIG	0.5
		Vinyl chloride	5/10/1996	0.8		0.5	ORIG	0.5
	IR02MW373A	Antimony	11/21/1995	6.3		3	ORIG	43.26
		Antimony	3/4/1996	145		1.6	ORIG	43.26
		Antimony	5/10/1996	41.8		1.2	ORIG	43.26
		Cadmium	11/21/1995	2.2		0.2	ORIG	5.08
		Cadmium	3/4/1996	5.8		0.2	ORIG	5.08
		Cadmium	5/10/1996	3.9		0.3	ORIG	5.08
		Lead	11/21/1995	3.7		1.2	ORIG	14.44
		Lead	3/4/1996	28.7	J	0.8	ORIG	14.44
		Lead	5/10/1996	17.4		1	ORIG	14.44
		Nickel	11/21/1995	28.9		1.3	ORIG	96.48
		Nickel	3/4/1996	543		0.7	ORIG	96.48
		Nickel	5/10/1996	554		0.9	ORIG	96.48
		Aroclor-1260	11/21/1995	1		0.5	ORIG	0.5
		Aroclor-1260	3/4/1996	0.5		0.5	ORIG	0.5
		Aroclor-1260	5/10/1996	0.5	U	0.5	ORIG	0.5
	IR02MW89A	Aluminum	1/22/1992	20	U	20	ORIG	1000
		Aluminum	7/21/1992	3560		21.6	ORIG	1000
		Aluminum	8/24/1992	21.6	U	21.6	ORIG	1000
		Nickel	1/22/1992	28.8	U	28.8	ORIG	96.48
		Nickel	7/21/1992	105		17.3	ORIG	96.48
		Nickel	8/24/1992	17.3	U	17.3	ORIG	96.48
	IR02MW93A	Nickel	3/22/1991	14.5	U	14.5	ORIG	96.48
		Nickel	3/22/1991	30		14.5	FDUP	96.48
		Nickel	1/6/1992	17	UJ	17	ORIG	96.48
		Nickel	1/6/1992	17	UJ	17	FDUP	96.48
		Nickel	8/24/1992	256		17.3	ORIG	96.48
	IR02MW97A	Cadmium	3/21/1991	2.7	U	2.7	ORIG	5.08
		Cadmium	1/15/1992	4	U	4	ORIG	5.08
		Cadmium	1/15/1992	4	U	4	FDUP	5.08
		Cadmium	8/24/1992	7		2.7	ORIG	5.08
		Cadmium	8/24/1992	3		2.7	FDUP	5.08
	IR02MWB-1	Aluminum	1/13/1992	19	U	19	ORIG	1000
		Aluminum	1/13/1992	20.1	U	20.1	FDUP	1000
		Aluminum	7/7/1992	49.5	UJ	49.5	ORIG	1000
		Aluminum	7/7/1992	29800	J	21.6	FDUP	1000
		Aluminum	8/27/1992	31.5	U	31.5	ORIG	1000
		Arsenic	1/13/1992	15.8		1	ORIG	36
		Arsenic	1/13/1992	12.8		1	FDUP	36
		Arsenic	7/7/1992	50.9		2	ORIG	36
		Arsenic	7/7/1992	65.8		2	FDUP	36
		Arsenic	8/27/1992	3.1	J	2	ORIG	36
		Chromium	1/13/1992	5	U	5	ORIG	50
		Chromium	1/13/1992	6.1		5	FDUP	50
		Chromium	7/7/1992	2.5	U	2.5	ORIG	50
		Chromium	7/7/1992	472	J	2.5	FDUP	50
		Chromium	8/27/1992	6.6		2.5	ORIG	50
		Nickel	1/13/1992	92.1	J	17	ORIG	96.48
		Nickel	1/13/1992	88.3	J	17	FDUP	96.48
		Nickel	7/7/1992	596	J	17.3	ORIG	96.48

IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-02 (A-aquifer) (cont.)	IR02MWB-1 (cont.)	Nickel	7/7/1992	1470	J	17.3	FDUP	96.48
		Nickel	8/27/1992	696		17.3	ORIG	96.48
	IR02MWB-2	Aluminum	1/7/1992	49.6	U	49.6	ORIG	1000
		Aluminum	7/7/1992	19200	J	21.6	ORIG	1000
		Aluminum	8/27/1992	21.6	U	21.6	ORIG	1000
		Chromium	1/7/1992	5	U	5	ORIG	50
		Chromium	7/7/1992	544	J	2.5	ORIG	50
		Chromium	8/27/1992	2.5	U	2.5	ORIG	50
		Lead	1/7/1992	3.8	J	1	ORIG	14.44
		Lead	7/7/1992	38.4		1.6	ORIG	14.44
		Lead	8/27/1992	16	UJ	16	ORIG	14.44
		Nickel	1/7/1992	125	J	17	ORIG	96.48
		Nickel	7/7/1992	235	J	17.3	ORIG	96.48
		Nickel	8/27/1992	71.1		17.3	ORIG	96.48
		Thallium	7/7/1992	17.5	J	8	ORIG	12.97
		Carbon tetrachloride	1/7/1992	5	U	5	ORIG	0.5
		Carbon tetrachloride	7/7/1992	11		5	ORIG	0.5
		Carbon tetrachloride	8/27/1992	5	U	5	ORIG	0.5
	IR02MWB-3	Aluminum	1/20/1992	32	U	32	ORIG	1000
		Aluminum	7/10/1992	8510		21.6	ORIG	1000
		Aluminum	8/27/1992	21.6	U	21.6	ORIG	1000
		Aluminum	8/27/1992	21.6	U	21.6	FDUP	1000
		Antimony	1/20/1992	52.1		26.3	ORIG	43.26
		Antimony	7/10/1992	556		31.1	ORIG	43.26
		Antimony	8/27/1992	45.4		31.1	ORIG	43.26
		Antimony	8/27/1992	37.5		31.1	FDUP	43.26
		Cadmium	1/20/1992	2.8	U	2.8	ORIG	5.08
		Cadmium	7/10/1992	23.6		2.7	ORIG	5.08
		Cadmium	8/27/1992	2.7	U	2.7	ORIG	5.08
		Cadmium	8/27/1992	2.7	U	2.7	FDUP	5.08
		Chromium	1/20/1992	2.7	U	2.7	ORIG	50
		Chromium	7/10/1992	242		2.5	ORIG	50
		Chromium	8/27/1992	2.5	U	2.5	ORIG	50
		Chromium	8/27/1992	2.5	U	2.5	FDUP	50
		Copper	1/20/1992	1.6	U	1.6	ORIG	28.04
		Copper	7/10/1992	3900	J	1.8	ORIG	28.04
		Copper	8/27/1992	2.5	J	1.8	ORIG	28.04
		Copper	8/27/1992	1.8	U	1.8	FDUP	28.04
		Lead	1/20/1992	0.8	U	0.8	ORIG	14.44
		Lead	7/10/1992	1350		23.6	ORIG	14.44
		Lead	8/27/1992	1.6	UJ	1.6	ORIG	14.44
		Lead	8/27/1992	1.6	UJ	1.6	FDUP	14.44
		Mercury	1/20/1992	0.2	U	0.2	ORIG	0.6
		Mercury	7/10/1992	24		1	ORIG	0.6
		Mercury	8/27/1992	0.2	U	0.2	ORIG	0.6
		Mercury	8/27/1992	0.2	U	0.2	FDUP	0.6
		Nickel	1/20/1992	28.8	U	28.8	ORIG	96.48
		Nickel	7/10/1992	269		17.3	ORIG	96.48
		Nickel	8/27/1992	17.3	U	17.3	ORIG	96.48
		Nickel	8/27/1992	17.3	U	17.3	FDUP	96.48
		Benzo(a)pyrene	1/20/1992	10	U	10	ORIG	0.2
		Benzo(a)pyrene	7/10/1992	2		10	ORIG	0.2
		Benzo(a)pyrene	8/27/1992	10	U	10	ORIG	0.2
		Benzo(a)pyrene	8/27/1992	10	U	10	FDUP	0.2
		Pentachlorophenol	1/20/1992	6		50	ORIG	1
		Pentachlorophenol	7/10/1992	3		50	ORIG	1
		Pentachlorophenol	8/27/1992	50	U	50	ORIG	1
		Pentachlorophenol	8/27/1992	50	U	50	FDUP	1
	IR02MWB-5	Aroclor-1260	1/21/1992	1	U	1	ORIG	0.5
		Aroclor-1260	6/9/1992	1	U	1	ORIG	0.5
		Aroclor-1260	6/9/1992	1	U	1	FDUP	0.5
		Aroclor-1260	8/28/1992	0.8		1	ORIG	0.5

IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-03	IR03MW218A1	Barium	1/24/1992	157		0.5	ORIG	1000
		Barium	1/24/1992	716		0.5	FDUP	1000
		Barium	7/9/1992	4830		0.6	ORIG	1000
		Lead	1/24/1992	0.8	U	0.8	ORIG	14.44
		Lead	1/24/1992	1.8		0.8	FDUP	14.44
		Lead	7/9/1992	23.4		1.6	ORIG	14.44
		Aroclor-1260	1/24/1992	10	U	10	ORIG	0.5
		Aroclor-1260	1/24/1992	10	U	10	FDUP	0.5
		Aroclor-1260	7/9/1992	32		50	ORIG	0.5
IR-03 (A-aquifer)	IR03MW218A2	Barium	1/15/1992	17300		2	ORIG	1000
		Barium	7/9/1992	18800		0.6	ORIG	1000
		Barium	8/27/1992	19400		0.6	ORIG	1000
		Lead	1/15/1992	2.4	U	2.4	ORIG	14.44
		Lead	7/9/1992	83		16	ORIG	14.44
		Lead	8/27/1992	1.6	UJ	1.6	ORIG	14.44
		Benzene	1/15/1992	13		5	ORIG	1
		Benzene	7/9/1992	10		5	ORIG	1
		Benzene	8/27/1992	10		5	ORIG	1
	IR03MW218A3	Barium	1/16/1992	1460		2	ORIG	1000
		Barium	7/9/1992	1580		0.6	ORIG	1000
		Barium	8/27/1992	1540		0.6	ORIG	1000
		Benzene	1/15/1992	3		5	ORIG	1
		Benzene	7/9/1992	5	U	5	ORIG	1
		Benzene	8/27/1992	5	U	5	ORIG	1
	IR03MW224A	Aluminum	1/23/1992	20	U	20	ORIG	1000
		Aluminum	7/24/1992	21.6	U	21.6	ORIG	1000
		Aluminum	8/28/1992	20200		21.6	ORIG	1000
		Aluminum	8/28/1992	21.6	U	21.6	FDUP	1000
		Chromium	1/23/1992	3		2.7	ORIG	50
		Chromium	7/24/1992	2.5	U	2.5	ORIG	50
		Chromium	8/28/1992	63.6		2.5	ORIG	50
		Chromium	8/28/1992	2.5	U	2.5	FDUP	50
		Aroclor-1260	1/23/1992	1	U	1	ORIG	0.5
		Aroclor-1260	7/24/1992	0.5		1	ORIG	0.5
		Aroclor-1260	8/28/1992	0.7	J	1	ORIG	0.5
		Aroclor-1260	8/28/1992	0.7	J	1	FDUP	0.5
	IR03MW225A	Aroclor-1260	1/28/1992	3		2	ORIG	0.5
		Aroclor-1260	1/28/1992	4		5	FDUP	0.5
		Aroclor-1260	4/3/1996	0.5	U	0.5	ORIG	0.5
		Aroclor-1260	6/19/1996	2		0.5	ORIG	0.5
		1,4-Dichlorobenzene	1/28/1992	17		10	ORIG	5
		1,4-Dichlorobenzene	1/28/1992	16		10	FDUP	5
		1,4-Dichlorobenzene	4/3/1996	8		5	ORIG	5
		1,4-Dichlorobenzene	6/19/1996	10		5	ORIG	5
		1,2-Dichloroethene	1/28/1992	3		5	ORIG	0.5
		1,2-Dichloroethene	1/28/1992	4		5	FDUP	0.5
		1,2-Dichloroethene	4/3/1996	0.5	U	0.5	ORIG	0.5
		1,2-Dichloroethene	6/19/1996	0.5	U	0.5	ORIG	0.5
		Benzene	1/28/1992	3		5	ORIG	1
		Benzene	1/28/1992	3		5	FDUP	1
		Benzene	4/3/1996	1		0.5	ORIG	1
		Benzene	6/19/1996	3		0.5	ORIG	1
		CHLOROBenzene	1/28/1992	130		5	ORIG	70
		CHLOROBenzene	1/28/1992	150		5	FDUP	70
		CHLOROBenzene	4/3/1996	51		1	ORIG	70
		CHLOROBenzene	6/19/1996	75		1	ORIG	70
	IR03MW226A	Aluminum	1/27/1992	20	U	20	ORIG	1000
		Aluminum	1/27/1992	20	U	20	FDUP	1000
		Aluminum	7/24/1992	21.6	U	21.6	ORIG	1000
		Aluminum	7/24/1992	4900		21.6	FDUP	1000
		Aluminum	8/27/1992	21.6	U	21.6	ORIG	1000
		Antimony	1/27/1992	26.3	U	26.3	ORIG	43.26
		Antimony	1/27/1992	35	U	35	FDUP	43.26

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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-03 (A-aquifer) (cont.)	IR03MW226A (cont.)	Antimony	7/24/1992	31.1	U	31.1	ORIG	43.26
		Antimony	7/24/1992	63.9		31.1	FDUP	43.26
		Antimony	8/27/1992	31.1	U	31.1	ORIG	43.26
		Barium	1/27/1992	96.2		0.5	ORIG	1000
		Barium	1/27/1992	92.7		0.5	FDUP	1000
		Barium	7/24/1992	7070		0.6	ORIG	1000
		Barium	7/24/1992	6830		0.6	FDUP	1000
		Barium	8/27/1992	85.4		0.6	ORIG	1000
		Chromium	1/27/1992	2.7	U	2.7	ORIG	50
		Chromium	1/27/1992	2.7	U	2.7	FDUP	50
		Chromium	7/24/1992	2.5	U	2.5	ORIG	50
		Chromium	7/24/1992	68.6		2.5	FDUP	50
		Chromium	8/27/1992	2.5	U	2.5	ORIG	50
		Lead	1/27/1992	1.4		0.8	ORIG	14.44
		Lead	1/27/1992	1.6		0.8	FDUP	14.44
		Lead	7/24/1992	1.6	U	1.6	ORIG	14.44
		Lead	7/24/1992	613		16	FDUP	14.44
		Lead	8/27/1992	1.6	UJ	1.6	ORIG	14.44
		Nickel	1/27/1992	57.8	J	28.8	ORIG	96.48
		Nickel	1/27/1992	42.6	J	28.8	FDUP	96.48
		Nickel	7/24/1992	17.3	U	17.3	ORIG	96.48
		Nickel	7/24/1992	146		17.3	FDUP	96.48
		Nickel	8/27/1992	17.3	U	17.3	ORIG	96.48
		Aroclor-1260	1/27/1992	2	U	2	ORIG	0.5
		Aroclor-1260	1/27/1992	2	U	2	FDUP	0.5
		Aroclor-1260	7/24/1992	9		10	ORIG	0.5
		Aroclor-1260	7/24/1992	12		20	FDUP	0.5
		Aroclor-1260	8/27/1992	9		5	ORIG	0.5
		1,2-Dichloroethene	1/27/1992	5	U	5	ORIG	0.5
		1,2-Dichloroethene	1/27/1992	5	U	5	FDUP	0.5
		1,2-Dichloroethene	7/24/1992	3		5	ORIG	0.5
		1,2-Dichloroethene	7/24/1992	5	U	5	FDUP	0.5
		1,2-Dichloroethene	8/27/1992	5	U	5	ORIG	0.5
		Benzene	1/27/1992	5	U	5	ORIG	1
		Benzene	1/27/1992	5	U	5	FDUP	1
		Benzene	7/24/1992	3		5	ORIG	1
		Benzene	7/24/1992	3		5	FDUP	1
		Benzene	8/27/1992	4		5	ORIG	1
	IR03MW342A	Aluminum	7/6/1992	2570	J	21.6	ORIG	1000
		Aluminum	8/28/1992	14000		21.6	ORIG	1000
		Aluminum	7/24/1995	16.3	U	16.3	ORIG	1000
		Aluminum	3/21/1996	44.2	U	44.2	ORIG	1000
		Aluminum	3/21/1996	22.9	U	22.9	FDUP	1000
		Barium	7/6/1992	1380	J	0.6	ORIG	1000
		Barium	8/28/1992	1800		0.6	ORIG	1000
		Barium	7/24/1995	2010		0.3	ORIG	1000
		Barium	3/21/1996	1270		0.3	ORIG	1000
		Barium	3/21/1996	1230		0.3	FDUP	1000
		Chromium	7/6/1992	21.9	J	2.5	ORIG	50
		Chromium	8/28/1992	165		2.5	ORIG	50
		Chromium	7/24/1995	1.8	U	1.8	ORIG	50
		Chromium	3/21/1996	0.4	U	0.4	ORIG	50
		Chromium	3/21/1996	0.4	U	0.4	FDUP	50
		Lead	7/6/1992	92.5		3.2	ORIG	14.44
		Lead	8/28/1992	324	J	16	ORIG	14.44
		Lead	7/24/1995	1.5	U	1.5	ORIG	14.44
		Lead	3/21/1996	0.8	U	0.8	ORIG	14.44
		Lead	3/21/1996	0.8	U	0.8	FDUP	14.44
		Nickel	7/6/1992	74.8	J	17.3	ORIG	96.48
		Nickel	8/28/1992	332		17.3	ORIG	96.48
		Nickel	7/24/1995	3.3	U	3.3	ORIG	96.48
		Nickel	3/21/1996	0.7	U	0.7	ORIG	96.48
		Nickel	3/21/1996	0.7	U	0.7	FDUP	96.48

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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-03 (A-aquifer) (cont.)	IR03MW342A (cont.)	Pentachlorophenol	7/6/1992	6		50	ORIG	1
		Pentachlorophenol	8/28/1992	50	U	50	ORIG	1
		Pentachlorophenol	3/21/1996	25	U	25	ORIG	1
		Pentachlorophenol	3/21/1996	25	U	25	FDUP	1
		Benzene	7/6/1992	5	U	5	ORIG	1
		Benzene	8/28/1992	5		5	ORIG	1
		Benzene	3/21/1996	1		0.5	ORIG	1
		Benzene	3/21/1996	1		0.5	FDUP	1
	IR03MW369A	Benzene	11/29/1995	2	J	0.5	ORIG	1
		Benzene	3/6/1996	2		0.5	ORIG	1
		Benzene	5/20/1996	2		0.5	ORIG	1
	IR03MW370A	Barium	11/30/1995	1830		0.4	ORIG	1000
		Barium	3/6/1996	2110		0.3	ORIG	1000
		Barium	5/16/1996	1800		0.8	ORIG	1000
		Benzene	11/30/1995	2		0.5	ORIG	1
		Benzene	3/6/1996	2		0.5	ORIG	1
		Benzene	5/16/1996	1		0.5	ORIG	1
	IR03MW371A	Aroclor-1260	11/30/1995	1		0.5	ORIG	0.5
		Aroclor-1260	11/30/1995	1		0.5	FDUP	0.5
		Aroclor-1260	3/6/1996	0.7		0.5	ORIG	0.5
		Aroclor-1260	5/16/1996	0.5	U	0.5	ORIG	0.5
		Aroclor-1260	5/16/1996	0.5	U	0.5	FDUP	0.5
	IR03MWO-1	Aluminum	1/23/1992	20	U	20	ORIG	1000
		Aluminum	1/23/1992	20	U	20	FDUP	1000
		Aluminum	7/9/1992	37000	J	21.6	ORIG	1000
		Aluminum	8/28/1992	21.6	U	21.6	ORIG	1000
		Arsenic	1/23/1992	182	J	8.5	ORIG	36
		Arsenic	1/23/1992	138	J	8.5	FDUP	36
		Arsenic	7/9/1992	1180	J	80	ORIG	36
		Arsenic	8/28/1992	367	J	20	ORIG	36
		Barium	1/23/1992	557		0.5	ORIG	1000
		Barium	1/23/1992	827		0.5	FDUP	1000
		Barium	7/9/1992	11100		0.6	ORIG	1000
		Barium	8/28/1992	10800		0.6	ORIG	1000
		Chromium	1/23/1992	15.5		2.7	ORIG	50
		Chromium	1/23/1992	10.5		2.7	FDUP	50
		Chromium	7/9/1992	567		2.5	ORIG	50
		Chromium	8/28/1992	2.5	U	2.5	ORIG	50
		Copper	1/23/1992	3.7	U	3.7	ORIG	28.04
		Copper	1/23/1992	3.1	U	3.1	FDUP	28.04
		Copper	7/9/1992	3240		1.8	ORIG	28.04
		Copper	8/28/1992	2.2		1.8	ORIG	28.04
		Lead	1/23/1992	0.8	U	0.8	ORIG	14.44
		Lead	1/23/1992	0.8	U	0.8	FDUP	14.44
		Lead	7/9/1992	65		3.2	ORIG	14.44
		Lead	8/28/1992	1.6	UJ	1.6	ORIG	14.44
		Nickel	1/23/1992	365	J	28.8	ORIG	96.48
		Nickel	1/23/1992	237	J	28.8	FDUP	96.48
		Nickel	7/9/1992	1140		17.3	ORIG	96.48
		Nickel	8/28/1992	17.3	U	17.3	ORIG	96.48
		Aroclor-1260	1/23/1992	33		50	ORIG	0.5
		Aroclor-1260	1/23/1992	48		10	FDUP	0.5
		Aroclor-1260	7/9/1992	290		200	ORIG	0.5
		Aroclor-1260	8/28/1992	10	U	10	ORIG	0.5
		1,4-Dichlorobenzene	1/23/1992	57		40	ORIG	5
		1,4-Dichlorobenzene	1/23/1992	49		15	FDUP	5
		1,4-Dichlorobenzene	7/9/1992	66		10	ORIG	5
		1,4-Dichlorobenzene	8/28/1992	84		10	ORIG	5
		Benzene	1/23/1992	6		10	ORIG	1
		Benzene	1/23/1992	5		10	FDUP	1
		Benzene	7/9/1992	9		5	ORIG	1
		Benzene	8/28/1992	9		5	ORIG	1
		Trichloroethene	1/23/1992	10	U	10	ORIG	5

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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-03 (A-aquifer) (cont.)	IR03MWO-1 (cont.)	Trichloroethene	1/23/1992	10	U	10	FDUP	5
		Trichloroethene	7/9/1992	15		5	ORIG	5
		Trichloroethene	8/28/1992	5	U	5	ORIG	5
	IR03MW228B	Cadmium	5/6/1991	2.7	U	2.7	ORIG	5.08
		Cadmium	5/6/1991	2.7	U	2.7	FDUP	5.08
		Cadmium	1/16/1992	4	U	4	ORIG	5.08
		Cadmium	8/28/1992	5.6		2.7	ORIG	5.08
IR-04	IR04MW13A	1,1,2,2-Tetrachloroethane	11/14/1991	5	U	5	ORIG	1
		1,1,2,2-Tetrachloroethane	2/12/1992	5	U	5	ORIG	1
		1,1,2,2-Tetrachloroethane	2/12/1992	5	U	5	FDUP	1
		1,1,2,2-Tetrachloroethane	6/17/1992	5	U	5	ORIG	1
		1,1,2,2-Tetrachloroethane	6/17/1992	2		5	FDUP	1
		1,1-Dichloroethane	11/14/1991	34		5	ORIG	5
		1,1-Dichloroethane	2/12/1992	45		5	ORIG	5
		1,1-Dichloroethane	2/12/1992	55		5	FDUP	5
		1,1-Dichloroethane	6/17/1992	40		5	ORIG	5
		1,1-Dichloroethane	6/17/1992	46		5	FDUP	5
		1,1-Dichloroethene	11/14/1991	20		5	ORIG	6
		1,1-Dichloroethene	2/12/1992	32		5	ORIG	6
		1,1-Dichloroethene	2/12/1992	38		5	FDUP	6
		1,1-Dichloroethene	6/17/1992	32		5	ORIG	6
		1,1-Dichloroethene	6/17/1992	34		5	FDUP	6
		1,2-Dichloroethene	11/14/1991	5	U	5	ORIG	0.5
		1,2-Dichloroethene	2/12/1992	5	U	5	ORIG	0.5
		1,2-Dichloroethene	2/12/1992	5	U	5	FDUP	0.5
		1,2-Dichloroethene	6/17/1992	5	U	5	ORIG	0.5
		1,2-Dichloroethene	6/17/1992	1		5	FDUP	0.5
		Tetrachloroethene	11/14/1991	19		5	ORIG	5
		Tetrachloroethene	2/12/1992	38		5	ORIG	5
		Tetrachloroethene	2/12/1992	52		5	FDUP	5
		Tetrachloroethene	6/17/1992	22		5	ORIG	5
		Tetrachloroethene	6/17/1992	32		5	FDUP	5
		Trichloroethene	11/14/1991	8		5	ORIG	5
		Trichloroethene	2/12/1992	20		5	ORIG	5
		Trichloroethene	2/12/1992	23		5	FDUP	5
		Trichloroethene	6/17/1992	10	U	10	ORIG	5
		Trichloroethene	6/17/1992	16		5	FDUP	5
	IR04MW31A	Arsenic	11/14/1991	1.4	U	1.4	ORIG	36
		Arsenic	2/12/1992	4.3		2	ORIG	36
		Arsenic	6/17/1992	208		20	ORIG	36
	IR04MW35A	Nickel	11/14/1991	147		17.8	ORIG	96.48
		Nickel	2/12/1992	11.5		4.4	ORIG	96.48
		Nickel	6/15/1992	46.1		17.3	ORIG	96.48
		Tetrachloroethene	11/14/1991	5	U	5	ORIG	5
		Tetrachloroethene	2/12/1992	5		2	ORIG	5
		Tetrachloroethene	6/15/1992	2		5	ORIG	5
	IR04MW36A	Arsenic	11/14/1991	156		5.6	ORIG	36
		Arsenic	11/14/1991	149		14	FDUP	36
		Arsenic	2/13/1992	159		2	ORIG	36
		Arsenic	2/13/1992	169		2	FDUP	36
		Arsenic	6/17/1992	4.6		2	ORIG	36
	IR04MW37A	Trichloroethene	11/21/1991	5		5	ORIG	5
		Trichloroethene	2/14/1992	8		5	ORIG	5
		Trichloroethene	2/14/1992	8		5	FDUP	5
		Trichloroethene	6/15/1992	5	U	5	ORIG	5
		Trichloroethene	6/15/1992	4	U	4	FDUP	5
	IR04MW39A	Trichloroethene	11/21/1991	9		5	ORIG	5
		Trichloroethene	2/13/1992	10		5	ORIG	5
		Trichloroethene	6/15/1992	10	U	10	ORIG	5
IR-04 (A-aquifer)	IR04MW40A	Cadmium	11/15/1991	11.6	U	11.6	ORIG	5.08
		Cadmium	11/15/1991	13		11.6	FDUP	5.08
		Cadmium	2/13/1992	1.8	U	1.8	ORIG	5.08
		Cadmium	6/17/1992	2.7	U	2.7	ORIG	5.08

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IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-04 (A-aquifer) (cont.)	IR04MW40A (cont.)	Lead	11/15/1991	2	U	2	ORIG	14.44
		Lead	11/15/1991	2	U	2	FDUP	14.44
		Lead	2/13/1992	15.4		1.5	ORIG	14.44
		Lead	6/17/1992	1.6	U	1.6	ORIG	14.44
		Nickel	11/15/1991	250		89	ORIG	96.48
		Nickel	11/15/1991	302		89	FDUP	96.48
		Nickel	2/13/1992	20.7		4.4	ORIG	96.48
		Nickel	6/17/1992	34.8		17.3	ORIG	96.48
IR-05	IR05MW73A	Aroclor-1260	11/21/1991	1	U	1	ORIG	0.5
		Aroclor-1260	11/21/1991	1	U	1	FDUP	0.5
		Aroclor-1260	2/11/1992	1	U	1	ORIG	0.5
		Aroclor-1260	6/19/1992	0.8		1	ORIG	0.5
	IR05MW77A	Lead	11/18/1991	2	U	2	ORIG	14.44
		Lead	2/10/1992	31.4	J	1.5	ORIG	14.44
		Lead	2/10/1992	20.4	J	1.5	FDUP	14.44
		Lead	6/18/1992	1.6	UJ	1.6	ORIG	14.44
	IR05MW85A	Arsenic	6/18/1992	126		10	ORIG	36
		Arsenic	6/18/1992	148		10	FDUP	36
		Arsenic	7/24/1992	102		2	ORIG	36
		Arsenic	7/24/1992	83.6		4	FDUP	36
		Arsenic	7/27/1995	27.4		2.8	ORIG	36
		Arsenic	7/27/1995	25.1		2.8	FDUP	36
		Arsenic	3/21/1996	13.5		1.4	ORIG	36
		Cadmium	6/18/1992	2.7	U	2.7	ORIG	5.08
		Cadmium	6/18/1992	2.7	U	2.7	FDUP	5.08
		Cadmium	7/24/1992	2.7	U	2.7	ORIG	5.08
		Cadmium	7/24/1992	7.2		2.7	FDUP	5.08
		Cadmium	7/27/1995	0.2	U	0.2	ORIG	5.08
		Cadmium	7/27/1995	0.2	U	0.2	FDUP	5.08
		Cadmium	3/21/1996	0.2	U	0.2	ORIG	5.08
		Mercury	6/18/1992	11		1	ORIG	0.6
		Mercury	6/18/1992	6.2		1	FDUP	0.6
		Mercury	7/24/1992	9.4		1	ORIG	0.6
		Mercury	7/24/1992	6.7		1	FDUP	0.6
		Mercury	7/27/1995	0.1	U	0.1	ORIG	0.6
		Mercury	7/27/1995	0.1	U	0.1	FDUP	0.6
		Mercury	3/21/1996	0.17		0.1	ORIG	0.6
IR-11	IR11MW25A	Carbon tetrachloride	3/10/1989	5	U	5	ORIG	0.5
		Carbon tetrachloride	8/22/1990	0.5	U	0.5	ORIG	0.5
		Carbon tetrachloride	8/22/1990	0.5	U	0.5	FDUP	0.5
		Carbon tetrachloride	11/22/1991	2		5	ORIG	0.5
		Carbon tetrachloride	9/14/1992	5	U	5	ORIG	0.5
		Tetrachloroethene	3/10/1989	5	U	5	ORIG	5
		Tetrachloroethene	8/22/1990	0.5	U	0.5	ORIG	5
		Tetrachloroethene	8/22/1990	0.5	U	0.5	FDUP	5
		Tetrachloroethene	11/22/1991	38		5	ORIG	5
		Tetrachloroethene	9/14/1992	5	U	5	ORIG	5
	IR11MW26A	Tetrachloroethene	3/10/1989	5	U	5	ORIG	5
		Tetrachloroethene	3/10/1989	5	U	5	FDUP	5
		Tetrachloroethene	8/21/1990	0.5	U	0.5	ORIG	5
		Tetrachloroethene	11/22/1991	21		5	ORIG	5
		Tetrachloroethene	9/14/1992	5	U	5	ORIG	5
IR-11 (A-aquifer)	IR11MW27A	Tetrachloroethene	3/10/1989	5	U	5	ORIG	5
		Tetrachloroethene	8/21/1990	0.5	U	0.5	ORIG	5
		Tetrachloroethene	11/22/1991	9		5	ORIG	5
		Tetrachloroethene	9/14/1992	5	U	5	ORIG	5
IR-12	IR12MW13A	1,1-Dichloroethane	8/26/1991	4		5	ORIG	5
		1,1-Dichloroethane	2/24/1992	5	U	5	ORIG	5
		1,1-Dichloroethane	2/24/1992	5	U	5	FDUP	5
		1,1-Dichloroethane	9/22/1992	6		5	ORIG	5
		1,1-Dichloroethane	9/22/1992	6		5	FDUP	5
	IR12MW17A	Barium	8/19/1992	281		0.6	ORIG	1000
		Barium	8/19/1992	255		0.6	FDUP	1000

IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-12 (cont.)	IR12MW17A (cont.)	Barium	9/24/1992	481		2.9	ORIG	1000
		Barium	3/22/1996	1040		0.3	ORIG	1000
		1,1-Dichloroethane	8/19/1992	5	U	5	ORIG	5
		1,1-Dichloroethane	8/19/1992	5	U	5	FDUP	5
		1,1-Dichloroethane	9/24/1992	10	U	10	ORIG	5
		1,1-Dichloroethane	3/22/1996	17		0.5	ORIG	5
		Benzene	8/19/1992	1		5	ORIG	1
		Benzene	8/19/1992	1		5	FDUP	1
		Benzene	9/24/1992	10	U	10	ORIG	1
		Benzene	3/22/1996	6		0.5	ORIG	1
	IR12MW18A	Arsenic	8/19/1992	62.8		2	ORIG	36
		Arsenic	9/24/1992	16.3	UJ	16.3	ORIG	36
		Arsenic	9/24/1992	23.2	J	3.1	FDUP	36
		Arsenic	3/25/1996	1.4	U	1.4	ORIG	36
		Arsenic	3/25/1996	1.7		1.4	FDUP	36
		Nickel	8/19/1992	213		17.3	ORIG	96.48
		Nickel	9/24/1992	205		4.8	ORIG	96.48
		Nickel	9/24/1992	214		4.8	FDUP	96.48
		Nickel	3/25/1996	153		0.7	ORIG	96.48
		Nickel	3/25/1996	154		0.7	FDUP	96.48
	IR12MW19A	1,1-Dichloroethane	8/19/1992	17		5	ORIG	5
		1,1-Dichloroethane	9/25/1992	28		10	ORIG	5
		1,1-Dichloroethane	9/25/1992	27		10	FDUP	5
		1,1-Dichloroethane	3/25/1996	19		0.5	ORIG	5
		1,2-Dichloroethene	8/19/1992	2		5	ORIG	0.5
		1,2-Dichloroethene	9/25/1992	10	U	10	ORIG	0.5
		1,2-Dichloroethene	9/25/1992	10	U	10	FDUP	0.5
		1,2-Dichloroethene	3/25/1996	0.9		0.5	ORIG	0.5
		Tetrachloroethene	8/19/1992	5		5	ORIG	5
		Tetrachloroethene	9/25/1992	7		10	ORIG	5
		Tetrachloroethene	9/25/1992	6		10	FDUP	5
		Tetrachloroethene	3/25/1996	6		0.5	ORIG	5
	IR12MW21A	Barium	8/19/1992	1090		0.6	ORIG	1000
		Barium	9/23/1992	754		2.9	ORIG	1000
		Barium	4/2/1996	528		0.8	ORIG	1000
		Barium	5/2/1996	559		0.8	ORIG	1000
		Cadmium	8/19/1992	2.7	U	2.7	ORIG	5.08
		Cadmium	9/23/1992	1.7	U	1.7	ORIG	5.08
		Cadmium	4/2/1996	0.3	U	0.3	ORIG	5.08
		Cadmium	5/2/1996	6	J	0.3	ORIG	5.08
IR-14	IR14MW09A	Nickel	11/27/1991	125		17.8	ORIG	96.48
		Nickel	11/27/1991	130		17.8	FDUP	96.48
		Nickel	2/26/1992	29.8		28.8	ORIG	96.48
		Nickel	2/26/1992	28.8	U	28.8	FDUP	96.48
		Nickel	9/15/1992	57		4.8	ORIG	96.48
	IR14MW10A	Antimony	11/22/1991	138	U	138	ORIG	43.26
		Antimony	11/22/1991	138	U	138	FDUP	43.26
		Antimony	2/26/1992	43.6		26.3	ORIG	43.26
		Antimony	9/15/1992	29.2		26.3	ORIG	43.26
		Antimony	9/15/1992	26.3	U	26.3	FDUP	43.26
		Cadmium	11/22/1991	11.6	U	11.6	ORIG	5.08
		Cadmium	11/22/1991	12.6		11.6	FDUP	5.08
		Cadmium	2/26/1992	2.8	U	2.8	ORIG	5.08
		Cadmium	9/15/1992	1.7	U	1.7	ORIG	5.08
		Cadmium	9/15/1992	1.7	U	1.7	FDUP	5.08
		Lead	11/22/1991	20	U	20	ORIG	14.44
		Lead	11/22/1991	20	U	20	FDUP	14.44
		Lead	2/26/1992	1.9	U	1.9	ORIG	14.44
		Lead	9/15/1992	18		1.3	ORIG	14.44
		Lead	9/15/1992	13	U	13	FDUP	14.44
	IR14MW12A	Cadmium	11/20/1991	14.1		4.6	ORIG	5.08
		Cadmium	2/26/1992	2.8	U	2.8	ORIG	5.08
		Cadmium	9/16/1992	1.7	UJ	1.7	ORIG	5.08

TABLE 3
RESULTS FOR THOSE CHEMICALS AND MONITORING WELLS
WHERE GROUNDWATER SAMPLE RESULTS EXCEED MCL SCREENING CRITERIA IN AT LEAST ONE SAMPLE
PARCEL E DATA GAP EVALUATION
HUNTERS POINT SHIPYARD
(Page 19 of 20)

IR Site	Station	Analyte	Sample Date	Result (mg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-14 (cont.)	IR14MW12A (cont.)	Nickel	11/20/1991	102		35.6	ORIG	96.48
		Nickel	2/26/1992	28.8	U	28.8	ORIG	96.48
		Nickel	9/16/1992	4.8	UJ	4.8	ORIG	96.48
	IR14MW13A	Barium	8/19/1992	3010		0.6	ORIG	1000
		Barium	9/23/1992	3920		2.9	ORIG	1000
		Barium	9/23/1992	3810		2.9	FDUP	1000
		Barium	4/2/1996	453		0.8	ORIG	1000
		Barium	5/9/1996	931		0.8	ORIG	1000
IR-15	IR15MW06A	Lead	11/20/1991	2	UJ	2	ORIG	14.44
		Lead	2/27/1992	1.3	U	1.3	ORIG	14.44
		Lead	9/14/1992	13	U	13	ORIG	14.44
		Lead	9/14/1992	127	J	1.3	FDUP	14.44
		Thallium	11/20/1991	2	UJ	2	ORIG	12.97
		Thallium	2/27/1992	18	J	18	ORIG	12.97
		Thallium	9/14/1992	16.5	U	16.5	ORIG	12.97
		Thallium	9/14/1992	33	U	33	FDUP	12.97
		1,1-Dichloroethane	11/20/1991	2		5	ORIG	5
		1,1-Dichloroethane	2/27/1992	3		5	ORIG	5
		1,1-Dichloroethane	9/14/1992	9		5	ORIG	5
		1,1-Dichloroethane	9/14/1992	5	U	5	FDUP	5
	IR15MW07A	Lead	11/20/1991	2	UJ	2	ORIG	14.44
		Lead	11/20/1991	2	U	2	FDUP	14.44
		Lead	2/27/1992	1.5	U	1.5	ORIG	14.44
		Lead	2/27/1992	1.4	U	1.4	FDUP	14.44
		Lead	9/16/1992	35.5	J	1.3	ORIG	14.44
	IR15MW09F	Bis(2-ethylhexyl)phthalate	8/14/1992	110		10	ORIG	4
		Bis(2-ethylhexyl)phthalate	9/22/1992	3	U	3	ORIG	4
		Bis(2-ethylhexyl)phthalate	3/27/1996	4	U	4	ORIG	4
	IR15MW10F	Arsenic	8/14/1992	4.3		2	ORIG	36
		Arsenic	9/22/1992	67.6	J	3.1	ORIG	36
		Arsenic	3/27/1996	3.7		1.4	ORIG	36
IR-36	IR36MW125A	Trichloroethene	1/24/1996	1000	J	25	ORIG	5
		Trichloroethene	3/15/1996	490		10	ORIG	5
		Trichloroethene	4/26/1996	860		25	ORIG	5
		Vinyl chloride	1/24/1996	25	UJ	25	ORIG	0.5
		Vinyl chloride	3/15/1996	22		0.5	ORIG	0.5
		Vinyl chloride	4/26/1996	25		2	ORIG	0.5
	IR36MW135A	Cadmium	1/9/1996	10.5		0.2	ORIG	5.08
		Cadmium	2/12/1996	0.2	U	0.2	ORIG	5.08
		Cadmium	3/15/1996	0.2	U	0.2	ORIG	5.08
	PA36MW04A	Vinyl chloride	2/5/1993	10	U	10	ORIG	0.5
		Vinyl chloride	2/7/1996	4		0.5	ORIG	0.5
		Vinyl chloride	3/11/1996	2		0.5	ORIG	0.5
		Trichloroethene	2/5/1993	6		10	ORIG	5
		Trichloroethene	2/7/1996	5		0.5	ORIG	5
		Trichloroethene	3/11/1996	1		0.5	ORIG	5
		Vinyl chloride	2/5/1993	10	U	10	ORIG	0.5
		Vinyl chloride	2/7/1996	4		0.5	ORIG	0.5
		Vinyl chloride	3/11/1996	2		0.5	ORIG	0.5
	PA36MW07A	Heptachlor	2/23/1993	0.1		0.05	ORIG	0.0036
		Heptachlor	2/8/1996	0.05	U	0.05	ORIG	0.0036
		Heptachlor	3/12/1996	0.05	U	0.05	ORIG	0.0036
IR-39	IR39MW21A	Aroclor-1260	6/22/1994	0.6	J	1	ORIG	0.5
		Aroclor-1260	1/23/1996	0.5	U	0.5	ORIG	0.5
		Aroclor-1260	2/26/1996	0.5	U	0.5	ORIG	0.5
		Heptachlor epoxide	6/22/1994	0.01	UJ	0.01	ORIG	0.01
		Heptachlor epoxide	1/23/1996	0.01	U	0.01	ORIG	0.01
		Heptachlor epoxide	2/26/1996	0.02		0.05	ORIG	0.01
		Benzene	6/22/1994	1500		100	ORIG	1
		Benzene	1/23/1996	66	J	5	ORIG	1
		Benzene	2/26/1996	61		10	ORIG	1
	IR39MW23A	Aluminum	9/15/1994	35.3	U	35.3	ORIG	1000
		Aluminum	9/15/1994	4160		35.3	FDUP	1000

TABLE 3
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PARCEL E DATA GAP EVALUATION
HUNTERS POINT SHIPYARD
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IR Site	Station	Analyte	Sample Date	Result (μg/L)	Qualifier	Detection Limit	Sample Type	MCL
IR-39 (cont.)	IR39MW23A (cont.)	Aluminum	1/26/1996	108	U	108	ORIG	1000
		Aluminum	1/26/1996	18	U	18	FDUP	1000
		Aluminum	2/26/1996	19.1	U	19.1	ORIG	1000
	IR39MW33A	Barium	1/23/1996	3880		0.3	ORIG	1000
		Barium	2/26/1996	3430		0.3	ORIG	1000
		Barium	3/29/1996	3750		0.3	ORIG	1000
		Benzene	1/23/1996	4		0.5	ORIG	1
		Benzene	2/26/1996	3	J	0.5	ORIG	1
		Benzene	3/29/1996	3		0.5	ORIG	1
IR-50	PA50MW10A	Cadmium	4/22/1993	1	U	1	ORIG	5.08
		Cadmium	10/15/1996	0.2	U	0.2	ORIG	5.08
		Cadmium	11/14/1996	7.2		1	ORIG	5.08
		Cadmium	11/14/1996	3.8		0.2	FDUP	5.08
		Lead	4/22/1993	1.3	U	1.3	ORIG	14.44
		Lead	10/15/1996	1.1	U	1.1	ORIG	14.44
		Lead	11/14/1996	133		5.5	ORIG	14.44
		Lead	11/14/1996	81.6		1.1	FDUP	14.44
IR-56	IR56MW39A	Benzene	11/2/1994	12	U	12	ORIG	1
		Benzene	11/2/1994	14	U	14	FDUP	1
		Benzene	3/4/1996	2	J	0.5	ORIG	1
		Benzene	5/15/1996	2		0.5	ORIG	1

Note: This table includes data from those wells and analytes where concentrations exceeded the greater of the MCL and the HGAL. Exceedances of National Ambient Water Quality Criteria are not shown.

μg/L Microgram per liter
FDUP Field Duplicate
IR Installation Restoration
J Quantity estimated
MCL Maximum contaminant limit, the lower of the state and federal MCL
ORIG Original sample (not a duplicate)
U Not detected

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Order 011

Prepared for

DEPARTMENT OF THE NAVY
Southwest Division
Naval Facilities Engineering Command
San Diego, California

QUALITY ASSURANCE PROJECT PLAN ADDENDUM FOR PHASE II GROUNDWATER DATA GAPS INVESTIGATION

HUNTERS POINT SHIPYARD SAN FRANCISCO, CALIFORNIA

DS.0011.15702

January 8, 2001

Prepared by

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QUALITY ASSURANCE PROJECT PLAN ADDENDUM
FOR PHASE II GROUNDWATER DATA GAPS INVESTIGATION

HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

Prepared for:

DEPARTMENT OF THE NAVY

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ABBREVIATIONS AND ACRONYMS

ARAR	Applicable or relevant and appropriate requirement
AST	Aboveground storage tank
AWQC	Ambient water quality criteria
BEC	BRAC Environmental Coordinator
bgs	Below ground surface
BHC	Benzene hexachloride
BRAC	Base Realignment and Closure
CAP	Corrective action plan
CARF	Contaminant-adjusted removal factor
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract laboratory program
COPC	Chemical of potential concern
CPR	Cardiopulmonary resuscitation
CQI	Continuous quality improvement
CRDL	Contract-required detection limit
CRQL	Contract-required quantitation limit
CTO	Contract task order
4,4’-DDE	Dichlorodiphenyltrichloroethene
4,4’-DDT	Dichlorodiphenyltrichloroethane
DHS	California Department of Health Services
DNAPL	Dense nonaqueous-phase liquid
DOT	U.S. Department of Transportation
DQO	Data quality objective
EDD	Electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
EWI	Environmental work instruction
Fe2+	Ferrous iron
Fe3+	Ferric iron
FS	Feasibility study
FSP	Field sampling plan
GC	Gas chromatograph
GDGI	Groundwater data gaps investigation
GIS	Geographic information system

ABBREVIATIONS AND ACRONYMS (Continued)

HGAL	Hunters Point Shipyard groundwater ambient level
HPAL	Hunters Point Shipyard ambient level
HPS	Hunters Point Shipyard
HSM	Health and safety manager
HSP	Health and safety plan
IC	Installation coordinator
ICP	Inductively coupled plasma
ID	Identification
IDL	Instrument detection limit
IDW	Investigation-derived waste
IR	Installation Restoration
LCS	Laboratory control sample
LIMS	Laboratory information management system
µg/L	Micrograms per liter
MDL	Method detection limit
mL	Milliliter
Mn2+	Manganese (II)
MS	Matrix spike
MSD	Matrix spike duplicate
NAWQC	National Ambient Water Quality Criteria
NEDTS	Navy Environmental Data Transfer Standard
NFESC	Naval Facilities Engineering Service Center
NRDL	Naval Radiological Defense Laboratory
ORC	Oxygen release compound
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear aromatic hydrocarbon
PARCC	Precision, accuracy, representativeness, completeness, and comparability
PCB	Polychlorinated biphenyl
PE	Performance evaluation
PM	Project manager
POC	Point of compliance
PPE	Personal protective equipment
PRC	PRC Environmental Management, Inc.
PVC	Polyvinyl chloride
QA	Quality assurance
QAO	Quality assurance officer

ABBREVIATIONS AND ACRONYMS (Continued)

QAPP	Quality assurance project plan
QC	Quality control
QCC	Quality control coordinator
QCSR	Quality control summary report
RAMP	Remedial action monitoring plan
RG	Registered Geologist
RI	Remedial investigation
ROD	Record of decision
RPD	Relative percent difference
RPM	Remedial project manager
RU	Remedial unit
RWQCB	Regional Water Quality Control Board
SAP	Sampling and analysis plan
SDG	Sample delivery group
SOP	Standard operating procedure
SOW	Scope of work
SQL	Sample quantitation limit
SVOC	Semivolatile organic compound
SWDIV	Naval Facilities Engineering Command, Southwest Division
TBD	To be determined
TCE	Trichloroethene
TDS	Total dissolved solids
TIC	Tentatively identified compound
TIZ	Tidally influenced zone
TPH	Total petroleum hydrocarbons
TPH-e	TPH-extractables
TPH-p	TPH-purgeables
TtEMI	Tetra Tech EM Inc.
UST	Underground storage tank
VOC	Volatile organic compound

A1 INTRODUCTION

Tetra Tech EM Inc. (TtEMI) received contract task orders (CTO) 005 and 011 under Comprehensive Long-term Environmental Action Navy Contract No. N62474-94-D-7609 (CLEAN II) from the Department of the Navy (Navy), Naval Facilities Engineering Command, Southwest Division (SWDIV) to conduct a remedial investigation (RI) through record-of-decision activities at Parcels D and E (CTO 005) and Parcels B and C (CTO 011) at Hunters Point Shipyard (HPS) in San Francisco, California. TtEMI received subsequent modifications to CTOs 005 and 011 to evaluate groundwater data gaps.

A phased approach is being used in implementing the current groundwater data gaps investigation (GDGI). The Phase I GDGI was conducted at Parcels C and D at HPS from July 2000 to December 2000. The Phase I GDGI was conducted in accordance with the associated planning document titled "Final Field Sampling Plan and Quality Assurance Project Plan for Phase I Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California," dated July 31, 2000 (TtEMI 2000a, see also Appendix A of the FSP addendum). The scope of work (SOW) for the Phase II GDGI will include sampling of the groundwater monitoring wells at Parcels C and D that were sampled or installed during the Phase I GDGI. The Phase II GDGI SOW will also include sampling of existing groundwater monitoring wells at Parcel E at HPS. Development of the SOW for the Phase II GDGI is based on the input from the HPS Base Realignment and Closure (BRAC) Cleanup Team (BCT) provided during two working meetings that were conducted in November and December 2000 (SWDIV 2000a, 2000b), as detailed in the field sampling plan (FSP) addendum that accompanies this document. The results of the Phase I GDGI were summarized in a document titled "Information Package for the Phase I Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California," dated December 1, 2000. To address concerns discussed during the December 5, 2000 working meeting, a revised Phase I GDGI information package will be submitted on January 8, 2000.

This quality assurance project plan (QAPP) addendum is a supplement to the "Final Field Sampling Plan and Quality Assurance Project Plan for Phase I Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California" dated July 31, 2000 (TtEMI 2000a, see also Appendix A of the FSP addendum) and approved by the Navy on July 25, 2000. It documents all changes in policies, project organization, and quality assurance and quality control (QA/QC) procedures to be implemented for the Phase II GDGI at HPS Parcels B, C, D, and E. However, for brevity, sections of the Phase I GDGI QAPP in which there were no changes will not be repeated in this QAPP addendum. The sections in which there were no changes instead are noted in the QAPP addendum text as having "no change."

The Phase II GDGI is focused on Parcels C, D, and E; however, additional areas of investigation in Parcel B are included in the Phase II GDGI to assess basewide groundwater flow patterns and to aid in the delineation of areas of investigation at parcel boundaries (specifically Installation Restoration [IR] Site 25 in Parcel C). Additional work may be required at Parcels B, C, D, and E in subsequent phases of the GDGI. In particular, the Phase III GDGI will include an additional round of sampling, as necessary, at the Parcel C and E locations specified in the accompanying FSP addendum. The QAPP, and the accompanying FSP, will be amended to be applicable to the subsequent phases of the GDGI.

The QAPP addendum (and the QAPP for the Phase I GDGI) fully describes the project data quality objectives (DQO), which have been developed through the seven-step DQO process (U.S. Environmental Protection Agency [EPA] 1999d), in accordance with EPA guidance for preparation of QAPPs (EPA 1998). Section A1.1 describes the format of the plan. Section A1.2 describes the proposed use of this QAPP, and Section A1.3 provides background information about the groundwater investigation. Section A1.4 describes the seven-step process by which the DQOs for this project were defined. Tables are presented where they are first cited in the text, while figures follow the text and the references. This QAPP addendum and the accompanying FSP addendum form the sampling and analysis plan (SAP) addendum; field crews are expected to have both the QAPP and the FSP addenda on hand at all times (in addition to the FSP and QAPP for the Phase I GDGI). Both documents are included in the same binder for easy reference.

A summary of the site background and the results of previous investigations is presented in this QAPP, while more detailed background and an analysis of site information are presented in the RI reports (PRC Environmental Management, Inc. [PRC] 1996a, 1997a, 1996b, 1997b, respectively) and the feasibility study (FS) reports (PRC 1996c; TtEMI 1998a; PRC 1997c; TtEMI 1998b, respectively) for Parcels B, C, D, and E. All field activities in support of the Phase II GDGI data collection and measurement activities will be conducted in accordance with TtEMI's "CLEAN II Program Health and Safety Plan (HSP), Revision I" (PRC 1995) and the basewide HSP (TtEMI 2000b).

A1.1 DOCUMENT REQUIREMENTS AND FORMAT

The format of this QAPP conforms to specifications set forth in "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations," EPA QA/R-5 (EPA 1999c) and "Guidance for the Data

Quality Objectives Process," EPA QA/G-4 (EPA 1999d). EPA QA/R-5 states that the requirements for QAPPs include (1) evaluating the DQOs for the project, (2) ensuring that intended measurements and data acquisitions are appropriate, (3) ensuring that QA/QC procedures are adequate to confirm data quality, and (4) identifying limitations on the use of the data. Table A-1 provides a summary of the elements of this QAPP.

TABLE A-1

QUALITY ASSURANCE PROJECT PLAN ELEMENTS

QAPP Element	EPA QAPP[1] Section Number	This QAPP Section Number
A. Project Management		
Title and approval sheet	A1	Report cover
Table of contents	A2	Page i
Distribution list	A3	Cover letter
Project/task organization	A4	A2
Problem definition/background	A5	A1, A3
Project/task description	A6	A4
Quality objectives and criteria for data measurement	A7	A5
Special training/certification	A8	A2.3
Documentation and records	A9	A6
B. Measurement/Data Acquisition		
Sampling process design (experimental design)	B1	B2
Sampling methods	B2	B3
Sample handling and custody	B3	B4
Analytical methods	B4	B5
Quality control	B5	B6
Instrument/equipment testing, inspection, and maintenance	B6	B7
Instrument/equipment calibration and frequency	B7	B7, B8
Inspection/acceptance of supplies and consumables	B8	B8
Nondirect measurements	B9	B9
Data management	B10	B9.3
C. Assessment/Oversight		
Assessments and response actions	C1	C1
Reports to management	C2	C1.3
D. Data Validation and Usability		
Data review, verification, and validation	D1	D1.1
Verification and validation methods	D2	D1.2
Reconciliation with user requirements	D3	D2

Note:

1 EPA 1999c

A1.2 USE OF THE DOCUMENT

Each element of the QAPP is discussed in this document as it pertains to the Phase II GDGI. The QAPP provides specific guidance and QA/QC criteria for collecting, evaluating, and submitting data while completing the project. To ensure the quality and usability of the data collected, all personnel working on the project are required to read and comply with the procedures set forth in this document.

A1.3 BACKGROUND

No change.

A1.3.1 Facility Location

No change.

A1.3.2 Facility Background

No change.

A1.3.3 Phase II Groundwater Data Gaps Investigation

The Phase II GDGI consists of four discrete tasks, as described further in the accompanying FSP addendum: (1) assess the condition of all existing wells, (2) measure basewide water levels to determine the pieziometric surface at existing A- and B-aquifer wells, (3) perform additional characterization of the B-aquifer in Parcels C, D, and E by sampling existing and newly installed wells for hydrogeologic and chemical parameters, and (4) resample existing A-aquifer and water-bearing-zone wells in Parcels C, D, and E for chemical parameters to confirm the extent of existing groundwater remedial units (RU). Task 1 was completed during the Phase I GDGI and is discussed in the accompanying FSP addendum. This QAPP addendum discusses tasks 2 though 4.

The Phase II GDGI is intended to provide additional data for revised FS reports for Parcels C, D, and E. The revised FS reports will include an evaluation of the beneficial uses of groundwater; this beneficial use evaluation was initiated in 1998. In response to comments from the regulatory agencies on the beneficial use evaluation, the Navy conducted a series of working meetings with the regulatory agencies and other stakeholders to evaluate historical groundwater data at Parcels C, D, and E that exceeded drinking-water standards (that is, the most stringent federal or state primary maximum contaminant levels [MCL]). During the working meetings, conducted on February 7, March 7, March 16, and March 23, 2000 (for Parcels C and D), several recommendations were made that additional sampling or evaluation be conducted. In particular, the Navy developed revised groundwater RUs at Parcels C and D, based on historical concentrations of contaminants in groundwater monitoring wells that exceeded drinking-water standards or ambient groundwater levels. The Navy proposed further evaluation of those areas. In addition, a working meeting to evaluate Parcel E groundwater data gaps was conducted on November 7, 2000. On the basis of the recommendations made during the working meetings, the Navy developed the scope of work for the Phase II GDGI, as presented in this QAPP addendum and the accompanying FSP addendum. The minutes from the Parcel E working meeting, the data summary tables used during the working meeting, and a summary of the rationale used in identifying the Parcel E data gaps are provided in Appendix B of the FSP addendum.

A1.4 DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements developed through the seven-step DQO process (EPA 1999d, 1999b). The primary outputs of that iterative methodology are definition of the problem under investigation (Step 1); identification of the decisions that require inputs and resolution (Step 2); identification of those inputs (Step 3); delineation of the study boundaries (Step 4); development of decision rules (Step 5); specification of tolerable limits on errors (Step 6); and optimization of the sampling design (Step 7). The seven-step DQO process for this project is presented in Sections A1.4.1 through A1.4.7; a summary of the DQO steps and related components is presented in Table A-2. The seven-step DQO process set forth in this QAPP addendum addresses the four tenets of the study respective to the Phase II GDGI. Task 1, the assessment of the condition of all wells that was completed during the Phase I GDGI, is discussed in this section.

TABLE A-2

IDENTIFICATION OF THE SEVEN STEPS OF THE DATA QUALITY OBJECTIVES PROCESS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Decision(s)**	**Identify Inputs to the Decision(s)**	**Define Study Boundaries**	**Develop Decision Rules**	**Specify Tolerable Limits on Error**	**Optimize Sampling Design**
<u>I:</u> Most monitoring wells at HPS have not been sampled in more than 4 years, and their conditions are unknown.	Which monitoring wells are in a condition that requires repair or redevelopment prior to sample collection or water level measurement? Which monitoring wells are in a condition that requires decommissioning and replacement prior to sample collection or water level measurement?	Comprehensive survey of condition of all existing monitoring wells. Survey includes measuring the total depth of the well to assess silt buildup, measuring the depth to water to compare to historical levels, measuring product thickness to compare to historical levels, and a visual inspection of the general integrity of the well.	Spatial boundaries of well condition survey are all existing monitoring wells at HPS. The temporal boundary of the well condition survey is 4 weeks.	• If a monitoring well has minor damage (for example, damaged surface casing), then repairs to such damage will be made. • If a monitoring well has significant damage (for example, damaged well casing) that is beyond repair, then the well will be decommissioned. If the well location is deemed necessary for future monitoring, then the well will be replaced. • If there is visual evidence of surface contamination entering the well casing, then the well will be redeveloped, decommissioned, replaced, or reassessed, as appropriate. • If a monitoring well is not damaged and does not show signs of surface contamination entering the well casing, then no action will be taken prior to sample collection. • If well sediment covers less than 10 percent of the well screen interval, then no redevelopment is necessary. • If well sediment covers 10 to 50 percent of the well screen interval, then the well will be redeveloped. • If well sediment covers more than 50 percent (or 3 feet, whichever is greater) of the well screen interval, then the well will be decommissioned. The well will be replaced if the location is deemed necessary for future monitoring.	Judgmental sampling is being utilized; therefore, a statistical model is not appropriate. Measurement quality objectives in the form of precision and accuracy goals are designed to minimize analytical errors.	Each well will be photographed for documentation purposes. Selection of sampling and measurement locations selected in basewide groundwater sampling plan will be biased to wells that do not require repair, redevelopment, or replacement, as possible without compromising the objectives of the GDGI. Wells that are needed for the sampling program will be repaired, redeveloped, or replaced as necessary. Efforts to repair, redevelop, or replace existing wells will be conducted first at wells selected for sampling and measurement in the FSP.
<u>II:</u> The most current A-aquifer and potentiometric surface map was generated more than 4 years ago and may not reflect current groundwater flow conditions. Recharge and discharge from utility lines may be affecting groundwater flow. Potential ground settling may affect current groundwater elevation measurements.	What is the current potentiometric surface of the A-aquifer (particularly in the vicinity of existing groundwater RUs)?	Water level measurements from approximately 202 existing A-aquifer locations, to be collected using a sounder. Evaluate water level measurement data and interpret the potentiometric surface using (1) an appropriate numeric interpolation technique and (2) modification by a California Registered Geologist. New survey measurements for the tops of well casings for all well locations included in the water level measurement event.	The areal limits of the water level measurement study area consist of A-aquifer wells previously sampled at HPS. The areal limits of the survey measurements are the boundaries of the facility. The vertical limit of the water level measurement study area is the depth of the A-aquifer wells installed at HPS. The vertical limit of the survey measurements is the ground surface or the top of the casing, whichever is appropriate. The temporal limit of a single water level measurement event is a period that will begin 1 hour before a high or low tide and will not extend beyond 3 hours after the same high or low tide. The temporal limit of the Phase II water level measurement study is 2 weeks (during which the wells will be sampled once). Subsequent water level measurement events may be conducted to account for seasonal variations.	• If the interpreted potentiometric surface at a given parcel predicts different flow directions when compared with historical data collected during the same season and at the same location, then the data may be further evaluated, depending on whether groundwater contamination is present, to identify the cause of the inconsistency. • If the interpreted potentiometric surface at a given parcel predicts different flow directions when compared with historical data collected in the same season and at the same location and groundwater flow potentially affects RUs, then an evaluation of potential flow impacts from utility lines will be conducted and utility lines will be repaired, if necessary, and new water level measurements will be collected. • If the interpreted potentiometric surface at a given parcel predicts different flow directions when compared with historical data collected in the same season and at the same location and groundwater flow in the area potentially affects RUs, and the data were not collected near utility lines, then (1) pressure transducers may be installed to confirm the data or (2) the data will be used to create an updated potentiometric surface map. • If the interpreted potentiometric surface at a given parcel does not predict different flow directions (compared to historical data collected in the same season and at the same location), then no action will be taken.	Judgmental sampling is being utilized; therefore, a statistical model is not appropriate. Measurement quality objectives in the form of precision and accuracy goals are designed to minimize analytical errors.	Well locations are selected to provide general coverage across HPS, with a focus on individual remedial RUs. Additional wells may be installed to assess potentiometric surface, as appropriate. The water level measurement period will be during relatively low tidal fluctuation in San Francisco Bay. The lowest fluctuation period during a 28-day lunar cycle is best, but may not be convenient because the high and low tides may occur during darkness. A low fluctuation period that allows groundwater measurement during daylight hours will be selected. The sampling design is described in further detail in the FSP. .

TABLE A-2 (Continued)

IDENTIFICATION OF THE SEVEN STEPS OF THE DATA QUALITY OBJECTIVES PROCESS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Decision(s)**	**Identify Inputs to the Decision(s)**	**Define Study Boundaries**	**Develop Decision Rules**	**Specify Tolerable Limits on Error**	**Optimize Sampling Design**
III: The extent of contamination in the B-aquifer and its relationship to the A-aquifer at Parcels C, D, and E (and, potentially, at a part of Parcel B) have not been evaluated because chemical and hydrogeologic data are insufficient to support an evaluation. Furthermore, TDS and yield data are insufficient to evaluate if cleanup to drinking water standards is necessary.	What is the nature and extent of contamination in the B-aquifer in (1) areas where Bay Mud does not separate the A- and B-aquifers, and (2) areas where the overlying A-aquifer is impacted by VOCs? What are the hydrogeologic conditions of the B-aquifer, (particularly in the vicinity of existing A-aquifer groundwater RUs)? Do TDS and yield values in the B-aquifer meet the state and/or federal criteria for exemption from potential use as a drinking water source?	Samples collected from 19 existing B-aquifer wells (including two nested A- and B-aquifer well pairs) and 20 new nested A- and B-aquifer well pairs will be analyzed for vertical gradient, yield, TDS, chemical concentrations, porosity, hydraulic conductivity, and geologic characteristics. Validated chemical data (with detection limits below the relevant ARARs) for COPCs in groundwater will be collected from existing and new B-aquifer wells. Chemical data will be mapped in plane view and cross section and input into the GIS database to establish the extent of B-aquifer contamination. Groundwater elevation data from 19 existing B-aquifer wells (in Parcels C and E) and 20 new B-aquifer wells (in Parcels B, C, and D) will be used to assess the magnitude and direction of the horizontal gradient of the B-aquifer.	The areal limits of the B-aquifer study area are the boundaries of Parcels B, C, D and E. The vertical limit of the B-aquifer study area is a depth of 5 feet below the bottom of the B-aquifer or to the bottom of VOC contamination, whichever is less. The temporal limit of the B-aquifer study is 2 months (in which the wells will be sampled once). Additional phases of the B-aquifer study may be conducted to account for seasonal variations.	• Evaluate chemical and hydrogeologic data to assess the nature and extent of B-aquifer contamination. If data indicate that A-aquifer contamination has migrated to the B-aquifer and is not adequately characterized, then additional sampling locations will be proposed for Phase II sampling to characterize the extent of the plume. • If a B-aquifer area does not contain chemicals at concentrations that exceed the most stringent primary MCL or HGAL (or NAWQC, as applicable), then the area will not be evaluated in the FS. • Evaluate TDS and yield data from the B-aquifer and compare to state and federal exemption criteria for drinking water sources. If a B-aquifer area contains chemicals at concentrations that exceed the most stringent primary MCL or HGAL but the area meets the state and federal exemption criteria, then ecological risk and human health risk via the inhalation exposure pathway will be evaluated and areas that result in risks through these pathways will be evaluated in the FS. • If a B-aquifer area contains chemicals at concentrations that exceed the most stringent primary MCL or HGAL and the area does not meet the state and federal exemption criteria, then the area will be evaluated in the FS. Note: If a B-aquifer area that meets the above criteria is part of a chemical plume that exceeds the most stringent primary MCL or HGAL, then the entire plume will be evaluated in the FS regardless of the state and federal exemption criteria.	Judgmental sampling is being utilized; therefore, a statistical model is not appropriate. Measurement quality objectives in the form of precision and accuracy goals are designed to minimize analytical errors.	New nested A- and B-aquifer well pair locations will be selected using the following guidelines: • Wells will be placed near areas of known A-aquifer contamination (as discussed in the working meetings in February and March 2000). • Wells will be placed to define potential contaminant migration in areas where Bay Mud does not separate the A- and B-aquifers. • If groundwater flow direction in either the A- or B-aquifer can be estimated, wells will be placed downgradient of known contamination.

TABLE A-2 (Continued)

IDENTIFICATION OF THE SEVEN STEPS OF THE DATA QUALITY OBJECTIVES PROCESS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Decision(s)**	**Identify Inputs to the Decision(s)**	**Define Study Boundaries**	**Develop Decision Rules**	**Specify Tolerable Limits on Error**	**Optimize Sampling Design**
IV: Existing A-aquifer and bedrock water-bearing zone ecological and human health RUs were developed on the basis of chemical data collected more than 4 years ago.	Are the RUs representative of current conditions at the site?	Validated chemical data (with detection limits below the relevant ARARs) for COPCs in groundwater will be collected from the existing A-aquifer and bedrock water-bearing zone wells, as detailed in the FSP.	The areal limits of the A-aquifer and bedrock water-bearing zone study area are the boundaries of Parcels B, C, D, and E. The vertical limit of the A-aquifer and bedrock water-bearing zone study area is the thickness of the A-aquifer and the depth of the bedrock water-bearing zone wells installed within the boundaries of Parcels B, C, D, and E. The temporal limit of the A-aquifer and bedrock water-bearing zone study is 2 months (in which the wells will be sampled once). Additional phases of the A-aquifer and bedrock water-bearing zone study may be conducted to account for seasonal variations.	Chemical data will be used to revise the boundaries of the existing RUs. Revisions will be made based on the following decision rules: • If the results for both sampling rounds at a well are below the MCLs or NAWQCs, then the boundaries of the existing RU will be revised (reduced) to reflect this change. • If the results for one or both sampling rounds at a well are not below the MCLs or NAWQCs, then the well will be retained in the RU; however, the boundary may be adjusted to reflect any changes. • If concentrations indicate that a plume has migrated, then additional sampling locations will be proposed for sampling in subsequent phases to characterize the extent of the plume.	Judgmental sampling is being utilized; therefore, a statistical model is not appropriate. Measurement quality objectives in the form of precision and accuracy goals are designed to minimize analytical errors.	Additional parameters may be collected to support remedial decisions, and to evaluate technologies in the feasibility study. The following criteria will be used to select wells for additional sampling: • Wells within previously identified RUs (based on ecological risk and human health risk via the inhalation exposure pathway) will be selected for resampling. • Certain wells surrounding previously identified RUs will be selected for resampling if historical data indicate chemicals are present at concentrations exceeding the MCLs, HGALs, or NAWQCs. • Certain wells with isolated detections of chemicals at concentrations exceeding the MCLs, HGALs, or NAWQCs will be selected for resampling. • Some wells surrounding previously identified RUs will be selected for resampling even if their historical data do not indicate the presence of chemicals at concentrations exceeding the MCLs, HGALs, or NAWQCs. The purpose of selecting these wells is to evaluate (1) the extent of the current RUs and (2) the potential for plume migration.

Notes:

ARAR Applicable or relevant and appropriate requirement
COPC Chemical of potential concern
FS Feasibility study
FSP Field sampling plan
GDGI Groundwater data gaps investigation
GIS Geographic information system
HGAL Hunters Point groundwater ambient level
HPS Hunters Point Shipyard
MCL Maximum contaminant level
NAWQC National Ambient Water Quality Criteria
RU Remedial unit
TDS Total dissolved solids
VOC Volatile organic compound

A1.4.1 Step 1 – State the Problem

Step 1 of the DQO process identifies the specific problem that requires investigation.

Four specific problems that require investigation are identified in Step 1:

1. Well Condition Survey

   Most monitoring wells on HPS have not been sampled in more than 4 years, and their conditions are unknown.

2. Water Level Measurement Study

   The most current A-aquifer potentiometric surface map was generated more than 4 years ago and may not reflect current groundwater flow conditions. Recharge and discharge from utility lines may be affecting groundwater flow. Potential ground settling may affect current groundwater elevations.

3. B-Aquifer Study

   The extent of contamination in the B-aquifer and its relationship to the A-aquifer at Parcels C, D, and E (and potentially at a part of Parcel B) have not been evaluated because chemical and hydrogeologic data are insufficient to support an evaluation.

   Further, data on total dissolved solids (TDS) and yield are insufficient to evaluate if cleanup to drinking water standards is necessary.

4. A-Aquifer and Bedrock Water-Bearing Zone Study

   Existing A-aquifer and bedrock water-bearing zone ecological and human health RUs were developed on the basis of chemical data collected more than 4 years ago.

A1.4.2 Step 2 – Identify the Decision

The purpose of this step is to define the decision statement that combines the key question the study will attempt to resolve with the alternative actions that may be taken.

The questions used to identify the decision(s) for each tenet in Step 2 are:

1. Well Condition Survey

   Which monitoring wells are in a condition that requires repair or redevelopment before samples are collected or water level measurements are taken?

   Which monitoring wells are in a condition that requires decommissioning and replacement before samples are collected or water level measurements are taken?

2. Water Level Measurement Study

   What is the current potentiometric surface of the A-aquifer (particularly in the vicinity of existing groundwater RUs)?

3. B-Aquifer Study

   What is the nature and extent of contamination in the B-aquifer in (1) areas in which Bay Mud does not separate the A- and B-aquifers and (2) areas in which the overlying A-aquifer is impacted by volatile organic compounds (VOC)?

   What are the hydrogeologic conditions of the B-aquifer (particularly in the vicinity of existing A-aquifer groundwater RUs)?

   Do TDS and yield values in the B-aquifer meet the state or federal criteria for exemption from potential use as a drinking water source?

4. A-Aquifer and Bedrock Water-Bearing Zone Study

   Are the RUs representative of current conditions at the site?

A1.4.3 Step 3 – Identify the Inputs to the Decision

The purpose of this step is to identify the information needed to support the decision statement and to specify which inputs will require environmental measurements.

Identified inputs to the decision for each tenet in Step 3 are:

1. Well Condition Survey

   A comprehensive survey of the condition of all existing monitoring wells was conducted. The survey included measurement of the total depth of the well to assess silt buildup, measurement of the depth to water to compare the current water level with historical levels, measurement of the thickness of product to compare to historical levels, and a visual inspection of the general integrity of the well.

2. Water Level Measurement Study

   A sounder was used to collect basewide water level measurements from approximately 202 existing A-aquifer locations (as detailed in the FSP).

   Water level measurement data will be evaluated and the potentiometric surface will be interpreted by (1) an appropriate numeric interpolation technique and (2) modification by a California Registered Geologist (RG).

   New survey measurements for the tops of well casings for all well locations included in the water level measurement event.

3. <u>B-Aquifer Study</u>

   Samples collected from 19 existing B-aquifer wells (including two nested A- and B-aquifer well pairs) and 20 new A- and B-aquifer well pairs (as detailed in the FSP) will be analyzed for vertical gradient, yield, TDS, chemical concentrations, porosity, hydraulic conductivity, and geology.

   Validated chemical data (with detection limits below the relevant ARARs) for chemicals of potential concern (COPC) in groundwater will be collected from existing and new B-aquifer wells.

   Chemical data will be mapped in plane view and cross-section and entered into the geographic information system (GIS) database to establish the extent of contamination in the B-aquifer.

   Groundwater elevation data from 19 existing B-aquifer wells (in Parcels C and E) and 20 new B-aquifer wells (in Parcels B, C, and D) will be used to assess the magnitude and direction of the horizontal gradient of the B-aquifer.

4. <u>A-Aquifer and Bedrock Water Bearing-Zone Study</u>

   Validated chemical data (with detection limits below the relevant ARARs) for COPCs in groundwater will be collected from the existing A-aquifer and bedrock water-bearing zone wells, as detailed in the FSP.

A1.4.4 Step 4 – Define the Study Boundaries

The purpose of this step is to define the site characteristics in terms of the spatial and temporal boundaries that the environmental measurements are intended to represent. The spatial boundaries of the sites are those that define the area to be studied. The temporal boundaries of the sites are those that describe the time frame of the study data and when proposed samples should be collected.

The study boundaries for each tenet in Step 4 are defined as follows:

1. <u>Well Condition Survey</u>

   The spatial boundaries of the well condition survey are all existing monitoring wells at HPS.

   The temporal boundary of the well condition survey is 4 weeks.

2. <u>Water Level Measurement Study</u>

   The areal limits of the water level measurement study area consist of A-aquifer wells at HPS that have been previously sampled. The areal limits of the survey measurements are the boundaries of the facility.

The vertical limit of the water level measurement study area is the depth of the A-aquifer wells that have been previously installed at HPS. The vertical limit of the survey measurements is the ground surface or the top of the casing, whichever is appropriate.

The temporal limit of the basewide water level measurement event is a period that will begin 1 hour before a high or low tide and will not extend beyond 3 hours after the same high or low tide. The temporal limit of the Phase II water level measurement study is 2 weeks (during which the wells will be sampled once). Subsequent water level measurement events may be conducted to account for seasonal variations.

3. B-Aquifer Study

The areal limits of the B-aquifer study area are the boundaries of Parcels B, C, D, and E.

The vertical limit of the B-aquifer study area is a depth of 5 feet below the bottom of the B-aquifer or to the bottom of VOC contamination, whichever is less.

The temporal limit of the B-aquifer study is 2 months (in which the wells will be sampled once). Additional phases of the B-aquifer study may be conducted to account for seasonal variations.

4. A-Aquifer and Bedrock Water-Bearing Zone Study

The areal limits of the A-aquifer and bedrock water-bearing zone study area are the boundaries of Parcels B, C, D, and E.

The vertical limit of the A-aquifer and bedrock water-bearing zone study area is the thickness of the A-aquifer and the depth of the bedrock water-bearing zone wells installed within the boundaries of Parcels B, C, D, and E.

The temporal limit of the A-aquifer and bedrock water-bearing zone study is 2 months (in which the wells will be sampled once). Additional phases of the A-aquifer and bedrock water-bearing zone study may be conducted to account for seasonal variations.

A1.4.5 Step 5 – Develop a Decision Rule

Step 5 of the DQO process defines the statistical parameter of interest, specifies the action level, and integrates study outputs into a single statement that describes the logical basis for choosing among alternative actions. Step 5 essentially delineates the consequences of the study results. Decision rules may be formulated as “if . . . then” statements, in which the outcome of the investigation provides direction for the next stage of the problem resolution. For example, if contamination is not detected, then the site may proceed to no further action; however, if contamination is found, then the site may proceed to remediation or further investigation that defines the conditions that will cause decision makers to choose among alternative actions.

One key point related to Step 5 is that the investigator should confirm that the specified action levels are greater than the detection and quantitation limits identified in Step 3, Identify the Inputs to the Decision. Analytical methods should be selected with both action levels and budgetary constraints in mind.

Decision rules developed for each tenet in Step 5 are:

1. Well Condition Survey

   If a monitoring well has minor damage (for example, a damaged surface casing), then repairs to such damage will be made.

   If a monitoring well has significant damage (for example, a damaged well casing) that is beyond repair, then the well will be decommissioned. If the well location is deemed necessary for future monitoring, then the well will be replaced.

   If there is visual evidence that surface contamination is entering the well casing, then the well will be redeveloped, decommissioned, replaced, or reassessed, as appropriate.

   If a monitoring well is not damaged and does not show signs that surface contamination is entering the well casing, then no action will be taken before samples are collected.

   If well sediment covers less than 10 percent of the well screen interval, then no redevelopment will be considered necessary.

   If well sediment covers 10 to 50 percent of the well screen interval, then the well will be redeveloped.

   If well sediment covers more than 50 percent (or 3 feet, whichever is greater) of the well screen interval, then the well will be decommissioned. If the location is deemed necessary for future monitoring, then the well will be replaced.

2. Water Level Measurement Study

   If the interpreted potentiometric surface at a given parcel predicts different flow directions when compared with historical data collected during the same season and at the same location, then the data may be further evaluated, depending on whether groundwater contamination is present, to identify the cause of the inconsistency.

   If the interpreted potentiometric surface at a given parcel predicts different flow directions when compared with historical data collected in the same season and at the same location and groundwater flow potentially affects RUs, then potential flow impacts from utility lines will be evaluated; utility lines will be repaired, if necessary; and new water level measurements will be collected.

   If the interpreted potentiometric surface at a given parcel predicts different flow directions when compared with historical data collected in the same season and at the same location, groundwater flow in the area potentially affects RUs, and the data were not collected near utility lines, then (1) pressure transducers may be installed to confirm the data, or (2) the data will be used to create an updated potentiometric surface map.

If the interpreted potentiometric surface at a given parcel does not predict different flow directions when compared with historical data collected in the same season and at the same location, then no action will be taken.

3. <u>B-Aquifer Study</u>

Evaluate chemical and hydrogeologic data to assess the nature and extent of B-aquifer contamination. If data indicate that A-aquifer contamination has migrated to the B-aquifer and is not adequately characterized, then additional sampling locations will be proposed for Phase II sampling to characterize the extent of the plume.

If a B-aquifer area does not contain chemicals at concentrations that exceed the most stringent primary MCL or Hunters Point groundwater ambient level (HGAL) (or National Ambient Water Quality Criteria [NAWQC], as applicable), then the area will not be evaluated in the FS.

Evaluate TDS and yield data from the B-aquifer and compare those data with state and federal exemption criteria for drinking water sources. If a B-aquifer area contains chemicals at concentrations that exceed the most stringent primary MCL or HGAL, but the area meets the state and federal exemption criteria, then ecological risk and human health risk through the inhalation exposure pathway will be evaluated, and areas that are found to pose risks through those pathways will be evaluated in the FS.

If a B-aquifer area contains chemicals at concentrations that exceed the most stringent primary MCL or HGAL and the area does not meet the state and federal exemption criteria, then the area will be evaluated in the FS. Note: If a B-aquifer area that meets the above criteria is affected by a chemical plume that exceeds the most stringent primary MCL or HGAL, then the entire plume will be evaluated in the FS, regardless of the state and federal exemption criteria.

4. <u>A-Aquifer and Bedrock Water-Bearing Zone Study</u>

Chemical data will be used to revise the boundaries of the existing RUs. Revisions will be made on the basis of the following decision rules:

- If the results for both sampling rounds at a well are below the MCLs or NAWQCs, then the boundaries of the existing RU will be revised (reduced) to reflect that change.
- If the results of one or both sampling rounds at a well are not below the MCLs or NAWQCs, then the well will be retained in the RU; however, the boundary may be adjusted as necessary to reflect any changes.
- If concentrations indicate that a plume has migrated, then additional sampling locations will be proposed for sampling in subsequent phases to characterize the extent of the plume.

A1.4.6 Step 6 – Specify Limits on Decision Errors

Step 6 of the DQO process quantifies the acceptable limits on decision errors. Such limits are needed to establish the level of uncertainty that will be acceptable and agreed upon by all stakeholders (such as regulatory agencies, citizens, and site owners). The acceptable level of error should be based on a consideration of the consequences of making an incorrect decision; that is, the consequences of both false-positive and false-negative errors should be evaluated.

The quality of the analytical data is also assessed under this step. Typically, the quality assessment involves specification of performance criteria in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the data. The performance criteria, termed the PARCC parameters, are discussed in Section A5.5 of this QAPP.

For each tenet in Step 6, judgmental sampling is being utilized; therefore, a statistical model is not appropriate. Measurement quality objectives in the form of precision and accuracy goals (discussed in Section A5.5) are designed to minimize analytical errors.

A1.4.7 Step 7 – Optimize the Design for Obtaining Data

The purpose of Step 7 of the DQO process is to identify a resource-effective design for generating environmental data that will meet the DQOs discussed in the previous sections.

In developing the sampling scheme for this groundwater monitoring program, several factors were evaluated. Those factors included monitoring well locations, sampling frequency, and analytes of concern.

Under this groundwater characterization program, analyses are proposed for specific contaminants: low-level contract laboratory program (CLP) VOCs, low-level CLP semivolatile organic compounds (SVOC), low-level CLP pesticides and polychlorinated biphenyls (PCB), CLP dissolved metals, total petroleum hydrocarbons-extractable (TPH-e), total petroleum hydrocarbons-purgeable (TPH-p), hexavalent chromium, and monitored natural attenuation (MNA) parameters. MNA parameters include reduced metals ferrous iron ($Fe2+$), ferric iron ($Fe3+$) and manganese (II) ($Mn2+$), nitrate, nitrite, sulfate, dissolved oxygen, oxidation-reduction potential, chloride, total alkalinity, hydroxide alkalinity, carbonate, bicarbonate, calcium, magnesium, sodium, potassium, and TDS. Decisions about analyses for analytes of concern for groundwater samples (that is, sampling suites) are based on knowledge of potential contaminant source areas and the laboratory analytical results from previous groundwater sampling events.

Tenets to optimize the sampling design in Step 7 are:

1. <u>Well Condition Survey</u>

   Each well was photographed for documentation.

   Selection of sampling and measurement locations in the basewide groundwater sampling plan will be biased toward wells that do not require repair, redevelopment, or replacement, to the extent possible without compromising the objectives of the GDGI.

   Wells that are needed for the sampling program will be repaired, redeveloped, or replaced as necessary. Efforts to repair, redevelop, or replace existing wells will be conducted first at wells selected for sampling and measurement in the FSP.

2. <u>Water Level Measurement Study</u>

   Well locations were selected to provide general coverage throughout HPS, in addition to focusing on individual RUs. Additional wells may be installed to assess the potentiometric surface, as appropriate.

   The water level measurement period occurred during a period of relatively low tidal fluctuation in San Francisco Bay. The lowest fluctuation period during a 28-day lunar cycle is best, but may not be convenient because the high and low tides may occur during darkness. A low fluctuation period that allows groundwater measurement during daylight hours will be selected.

   The sampling design is described in further detail in the FSP.

3. <u>B-Aquifer Study</u>

   New A- and B-aquifer well locations will be selected according to the following guidelines:

   - Wells will be placed near areas of known contamination in the A-aquifer (as discussed in working meetings with the BRAC Cleanup Team [BCT] in February and March 2000).

   - Wells will be placed appropriately to define potential contaminant migration in areas in which Bay Mud does not separate the A- and B-aquifers.

   - If groundwater flow direction in either the A- or the B-aquifer can be estimated, wells will be placed downgradient of known contamination.

4. A-Aquifer and Bedrock Water-Bearing Zone Study

The sampling design is described in further detail in the FSP.

Additional parameters may be collected to support remedial decisions and to evaluate technologies in the FS.

The following criteria will be used to select wells for additional sampling:

- Wells within previously identified RUs (chosen on the basis of ecological risk and human health risk through the inhalation exposure pathway) will be selected for resampling.
- Certain wells adjacent to previously identified RUs will be selected for resampling if historical data indicate that chemicals are present at concentrations that exceed the MCLs, HGALs, or NAWQCs.
- Certain wells for which there were isolated detections of chemicals at concentrations that exceed the MCLs, HGALs, or NAWQCs will be selected for resampling.
- Some wells adjacent to previously identified RUs will be selected for resampling even if their historical data do not indicate the presence of chemicals at concentrations that exceed the MCLs, HGALs, or NAWQCs. The purpose of selecting those wells is to evaluate (1) the extent of the current RUs and (2) the potential for plume migration.

A2 PROJECT AND TASK ORGANIZATION

This section discusses management of the Phase II GDGI. A well-organized project team, combined with adequate experience and proper training, will promote consistent quality throughout the investigation. Sections A2.1 and A2.2 present the task organization for the project, including the specific roles and responsibilities of project participants. Section A2.3 discusses training requirements for project members, and Section A2.4 identifies the schedule for the work to be conducted.

A2.1 PROJECT ORGANIZATION AND PERSONNEL

The following personnel are involved in the Phase II GDGI field efforts. In some cases, more than one responsibility has been assigned to a single individual. Figure A-1 shows an organization flow chart.

Name	Responsibility	Location	Telephone
David DeMars	Navy Lead Remedial Project Manager	Naval Facilities Engineering Command, San Diego, CA	(619) 532-0912
Narciso Ancog	Navy QA Officer (QAO)	Naval Facilities Engineering Command, San Diego, CA	(619) 532-2540
Richard Mach	BRAC Environmental Coordinator	Naval Facilities Engineering Command, San Diego, CA	(619) 532-0913
Daniel Chow	Program Manager	TtEMI, San Francisco, CA	(415) 222-8222
Mike Wanta	Installation Coordinator (IC)	TtEMI, San Francisco, CA	(415) 222-8241
Tong Li	Project Manager	TtEMI, Seattle, WA	(206) 587-4664
Greg Swanson	Program QA Manager	TtEMI, San Diego, CA	(619) 718-9676
Ron Ohta	Project QA Manager	TtEMI, Sacramento, CA	(916) 853-4506
Doug Sterling	On-site Quality Assurance Officer	TtEMI, San Francisco, CA	(415) 222-8270
Conrad Sherman	Program Health and Safety Manager (HSM)	TtEMI, San Francisco, CA	(415) 222-8377
William Warren	Project Health and Safety Coordinator	TtEMI, San Francisco, CA	(415) 222-8293
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A2.2 PROJECT TEAM RESPONSIBILITIES

No change.

A2.3 SPECIAL TRAINING AND CERTIFICATION

No change.

A2.3.1 Personnel Health and Safety Training

No change.

A2.3.2 Subcontractor Training

No change.

A2.4 PROJECT SCHEDULE

Table 8-1 of the accompanying FSP addendum presents the implementation schedule for sampling and analysis and the associated reporting.

A3 SITE BACKGROUND AND PROBLEM DEFINITION

As detailed in Section A1.4, the following four tasks will be conducted as part of the Phase II GDGI:

- Assess the condition of all existing groundwater wells (completed during the Phase I GDGI)
- Measure basewide water levels to determine the piezometric surface at existing A- and B-aquifers wells
- Perform additional characterization of the B aquifer in Parcels C, D, and E by sampling existing and newly installed wells for hydrogeologic and chemical parameters
- Resample A-aquifer wells in Parcels C, D, and E for chemical parameters to characterize the extent of contamination

Most of the existing groundwater monitoring wells at HPS were installed during RI activities conducted between 1990 and 1995. Future well installation and development activities under the Phase II GDGI will be performed in a manner consistent with procedures specified in the International Technology Corporation (IT Corp.) Remedial Action Work Plan, Revision 9 (see Section 10.0, References, in the FSP) and IT Corp. SOP 8.1 and 8.2 (see Appendix E of the FSP for the Phase I GDGI). Groundwater sampling methods will be consistent with the procedures presented in TtEMI SOPs No. 010 and 015 (see Appendix C of the FSP for the Phase I GDGI). Static groundwater levels will be measured in selected wells throughout HPS, as specified in the FSP.

Complete background information, such as geologic data on San Francisco Bay and HPS and information about HPS and site-specific operational histories, environmental restoration activities, and the results of environmental investigation and analysis, is presented in the RI reports (PRC 1996a, 1997a, 1996b, 1997b) and the FS reports (PRC 1996c, 1997c; TtEMI 1998a, 1998b).

The following sections present summary site backgrounds and describe in detail the purpose of the Phase II GDGI at Parcels C, D, and E. Table 4-4 of the accompanying FSP addendum provides a summary of data collection requirements, including the proposed analytical suite.

A3.1 PARCEL C

No change.

A3.1.1 Background

No change.

A3.1.2 Purpose of the Current Investigation

No change.

A3.2 PARCEL D

No change.

A3.2.1 Background

No change.

A3.2.2 Purpose of the Current Investigation

No change.

A3.3 PARCEL E

Parcel E areas that have significant groundwater contamination are located in IR-01/21, IR-02 Northwest, IR-02 Central, IR-02 Southeast, IR-03, IR-04, IR-05, IR-11/14/15, IR-12, IR-36, IR-39, IR-50, IR-56, IR-72, IR-73, and IR-75. A brief background of each IR site and a general description of the purpose of the current investigation at Parcel E are presented below.

A3.3.1 Background

This section discusses the background information for each of the Parcel E IR sites for which groundwater data gaps have been identified.

IR-01/21

IR-01/21 is located along the southwest shoreline of HPS in the northwest corner of Parcel E and covers approximately 46 acres. No buildings are known to have existed at IR-01/21; however, the site contains an industrial landfill that was operated from 1958 and 1974. Potential contaminant sources at IR-01/21 are:

- Sandblast waste
- Asbestos wastes
- Radium-containing devices
- Paints, solvents, and waste oils

Metals, VOCs, SVOCs, PCBs, pesticides, and radioactive compounds are the primary chemicals of concern (COC) in IR-01/21 groundwater. During recent working meetings conducted to evaluate Parcel E groundwater data gaps, additional sampling was deemed necessary to evaluate concentrations of the primary COCs. In addition, wells at IR-01/21 that contain petroleum hydrocarbons will be resampled and the results evaluated in the corrective action plan (CAP).

IR-02 Northwest

IR-02 Northwest covers approximately 8.9 acres along the southern shoreline of Parcel E southeast of the Industrial Landfill at IR-01/21. No roads, structures, or paved areas are present at IR-02 Northwest, but the Navy used the area as a disposal site for industrial waste. Potential contaminant sources at IR-02 Northwest are:

- Equipment with radium-containing components
- Liquid waste (solvents and waste oils)
- Sandblast waste
- Industrial debris (paint cans, drums, tanks, wire insulation, and pipe lagging)

IR-02 Central

IR-02 Central covers approximately 18 acres along the southern shoreline of Parcel E. IR-02 Central houses Building 600; the roads and parking lot near the building are the only paved areas. The site was used primarily as a disposal dump area. Potential contaminant sources at IR-02 Central are:

- Industrial debris, such as drums, paint cans, and asphalt
- Byproducts of combustion
- Liquid wastes, including solvents and waste oil containing PCBs
- Sandblast waste
- Lead and other metals at the firing range
- Radium-containing devices

IR-02 Southeast

- IR-02 Southeast covers approximately 10.1 acres along the southeastern shoreline of Parcel E. Currently, no buildings are present at IR-02 Southeast, but Quonset hut housing once occupied portions of the site. From 1945 to 1948, the southeastern portion of IR-02 Southeast was the site of a burn disposal area for domestic refuse. Potential contaminant sources at IR-02 Southeast are:
- Byproducts of combustion
- Liquid wastes, including waste oil containing PCBs
- Petroleum hydrocarbons
- Sandblast waste

Metals, VOCs, SVOCs, PCBs, pesticides, and radioactive compounds are the primary COCs in IR-02 Northwest, Central, and Southeast groundwater. During recent working meetings conducted to evaluate Parcel E groundwater data gaps, additional sampling was deemed necessary to evaluate concentrations of the primary COCs.

IR-03

IR-03 is located along the shoreline in the southeastern portion of Parcel E and covers approximately 10 acres. No buildings are present on IR-03; however, the site houses two former oil reclamation ponds (constructed approximately 30 feet from the shoreline) that the Navy used from 1944 to 1974 as part of a waste oil reclamation system. In addition, Triple A Machine Shop (Triple A) allegedly disposed sandblast waste, asphalt, and some liquids at IR-03 from 1976 and 1986. Potential contaminant sources at IR-03 are:

- Waste oils and fuels
- Sandblast waste

Metals, VOCs, SVOCs, PCBs, pesticides, and radioactive compounds are the primary COCs in IR-03 groundwater. During recent working meetings conducted to evaluate Parcel E groundwater data gaps, additional sampling was deemed necessary to evaluate concentrations of the primary COCs. In addition, wells at IR-03 that contain petroleum hydrocarbons will be resampled and the results evaluated in the CAP.

IR-04

IR-04 covers approximately 5.2 acres in the northwest corner of Parcel E. Approximately two acres of IR-04 make up the scrap yard and the scrap material area. No buildings are present on IR-04, and a railroad spur runs the length of the site. From 1954 to 1974, the Navy stored lead and copper electrical batteries and capacitors that were used in submarines at the site. From 1976 to 1986, Triple A allegedly expanded the scrap yard and used it for storage of scrap metal, drums, batteries, asbestos-containing pipe lagging material, and liquid waste. Potential contaminant sources at IR-04 are:

- Electrical capacitors
- Batteries
- Waste oil and other liquid wastes
- Scrap metal and debris

Metals (notably arsenic, cadmium, copper, lead, nickel, and zinc) and VOCs are the primary COCs in IR-04 groundwater. During recent working meetings conducted to evaluate Parcel E groundwater data gaps, additional sampling was deemed necessary to evaluate concentrations of the primary COCs.

IR-05

IR-05 covers approximately 4.3 acres in the northeastern portion of Parcel E, along the boundary of Parcel D. No buildings are present on IR-05, but three concrete pads are located along the northern boundary of the site. From 1946 to 1974, the Navy stored used electrical transformers of various sizes in an unpaved open yard approximately 400 feet north of Building 704. It was suspected that the transformers contained PCB oils that may have leaked onto the soil; the PCB-containing oil is the potential contaminant source at IR-05.

Metals (notably arsenic, cadmium, copper, lead, and mercury), SVOCs, and PCBs are the primary COCs in IR-05 groundwater. During recent working meetings conducted to evaluate Parcel E groundwater data gaps, additional sampling was deemed necessary to evaluate concentrations of the primary COCs.

IR-11/14/15

IR-11/14/15 covers 8.2 acres in the southeastern portion of Parcel E. Building 521 (a former power plant) and the concrete foundations of former buildings 506, 510, 510A, 518, 520, 529, and 531 are present at IR-11/14/15. The existing building and several former buildings at IR-11/14/15 were occupied by the Naval Radiological Defense Laboratory (NRDL) in the early 1950s. Potential contaminant sources at IR-11/14/15 are:

- Industrial debris, including drums, transformers, and chemical canisters
- Liquid waste disposal areas, located in the northern half of the site and in a fenced area northwest of Building 521, including waste oil that contains PCBs and fuel oil
- Byproducts of combustion at the incineration tank
- Sandblast waste (fill material and oily liquid waste disposal area)

Metals, VOCs, SVOCs, PCBs, pesticides, and radioactive compounds are the primary COCs in IR-11/14/15 groundwater. During recent working meetings conducted to evaluate Parcel E groundwater data gaps, additional sampling was deemed necessary to evaluate concentrations of the primary COCs. In addition, wells at IR-11/14/15 that contain petroleum hydrocarbons will be resampled and the results evaluated in the CAP.

IR-12

IR-12 covers approximately 8.5 acres in the central portion of Parcel E. IR-12 consists of two distinct areas, the disposal trench area and the salvage yard. The disposal trench area, which covers the southern third of the site and is also known as Triple A Site 4, contains a 40-foot-by-20-foot concrete pad where Triple A allegedly crushed drums and disposed of the associated solid and liquid waste in open trenches. The Navy and Triple A used the salvage yard, which covers the northern two-thirds of the site and is also known as Triple A Site 3, to store equipment for reuse. Triple A allegedly engaged in scrap metal stripping operations involving electrical cable, pipe lagging, and motor vehicles at the salvage yard. Potential contaminant sources at IR-12 are:

- Waste oils
- Metal debris
- Liquid wastes (such as acids, bases, chlorinated solvents, and lead-based paint)
- Solid wastes (such as paint chips and batteries)

Metals (notably arsenic, barium, and cadmium), VOCs, SVOCs, pesticides, and radioactive compounds are the primary COCs in IR-12 groundwater. During recent working meetings conducted to evaluate Parcel E groundwater data gaps, additional sampling was deemed necessary to evaluate concentrations of the primary COCs. In addition, wells at IR-12 that contain petroleum hydrocarbons will be resampled and the results evaluated in the CAP.

IR-36 North

IR-36 North covers approximately 9 acres in the northeastern portion of Parcel E and houses Buildings 400, 404A, and 405. The Navy used Building 400 as a storehouse for decommissioned ship parts and other equipment. Building 404A is a covered parking area used to store miscellaneous parts and equipment. The Navy used Building 405 as a supply storehouse for solvents, oil, gasoline, diesel fuel, formaldehyde, and chlorine. Potential contaminants identified at IR-36 North include: oil containing PCBs, solvents, oil, gasoline, diesel fuel, formaldehyde, and chlorine.

IR-36 South

IR-36 South covers approximately 12 acres in the central eastern portion of Parcel E and houses buildings 406, 413, and 414. Building 406 was used as a Navy supply storehouse for preservation and packaging operations equipment. In addition, equipment in the northwest portion of Building 406 (including a degreasing machine; tanks for solvent, acid, neutralizer, water rinse, a plastic dip, cold preservation dips, and hot preservation dips; and miscellaneous packaging equipment) was used to degrease parts before they were packaged for shipping. Building 413 was also a Navy supply storehouse. The Navy used Building 414, which has an exposed soil floor, as a public works facility and furniture storehouse. Potential contaminant sources identified at IR-36 South are:

- Neutralizers, solvents, and acids used at Building 406
- Waste oils from operations conducted at buildings 413 and 414

IR-36 West

IR-36 West covers approximately 7 acres in the central eastern portion of Parcel E and houses Buildings 371, 704, and 709 and the seven former USTs associated with Building 709. The Navy used Building 371 as a storehouse for miscellaneous equipment and Building 704 as an automotive repair shop. Currently, Wagner Construction Company uses Building 704 for the repair and storage of equipment and the area adjacent to buildings 371 and 704 as a storage yard for equipment and vehicles. Building 709 was used by the Navy as a service station and formerly contained five gasoline, diesel, and waste oil USTs (S-711 through S-715) next to Building 709; the USTs were removed in August 1991 during Phase I of the HPS UST program. In addition, two hydraulic fluid USTs (HPA-14 and HPA-15) were formerly located in Building 709; those USTs were removed in June 1993 during Phase II of the HPS UST program. Potential contaminant sources identified at IR-36 West are:

- Fuels, oils, acids, solvents, and electrolyte solution used at Building 704 (a Navy automotive repair shop)
- Fuels, oils, and solvents stored in the Wagner yard at Building 371
- Fuels and oils used at Building 709 (the service station)

Metals (notably aluminum, antimony, barium, cadmium, copper, and zinc), VOCs, SVOCs, PCBs, pesticides, and radioactive compounds are the primary COCs in IR-36 North, IR-36 South, and IR-36 West groundwater. During recent working meetings conducted to evaluate Parcel E groundwater data gaps, additional sampling was deemed necessary to evaluate concentrations of the primary COCs. In addition, wells at IR-36 North, IR-36 South, and IR-36 West that contain petroleum hydrocarbons will be resampled and the results evaluated in the CAP.

IR-56

IR-56 covers approximately 4.3 acres in the northern portion of Parcel E and houses Building 809. Building 809 was formerly used as a lumber storehouse; generators and drums and buckets of hydraulic fluids, bituminous solvent, and transmission fluid also were stored there. The open yard areas near Building 809 were used to store a variety of materials, including scrap metal, lumber, motors, batteries, hydraulic fluid, paints, solvents, waste oil, propane, hydrochloric acid, and unlabeled drums of liquid. Potential contaminant sources at IR-56 are:

- Waste fuels and waste oils that contain PCBs
- Metal debris
- Wood preservatives
- Liquid wastes (such as solvents, paint, hydraulic fluid, hydrochloric acid, and fuels)
- Solid wastes (such as scrap metal, lumber, motors, and batteries)

VOCs are the primary COCs in IR-56 groundwater. During recent working meetings conducted to evaluate Parcel E groundwater data gaps, additional sampling was deemed necessary to evaluate concentrations of COCs. In addition, wells at IR-56 that contain petroleum hydrocarbons will be resampled and the results evaluated in the CAP.

IR-72

IR-72 covers approximately 2.7 acres in the northern portion of Parcel E and houses Buildings 810 and 811, two gasoline USTs (S-801 and S-802) that have been closed in place, and the northern portion of Triple A Site 3. The Navy used Building 810 as a storehouse for paint and oil; the building also was used by commercial tenants from 1974 and 1988) to store drums of liquid waste, including pesticides, herbicides, and corrosives. An open area west of Building 810 was used as a storage yard for scrap metal, lumber, motors, batteries, hydraulic fluid, waste oil, propane, hydrochloric acid, and unlabelled drums of liquid; the storage yard also contained an AST used to store PCB-containing waste oil. Building 811 was formerly a diesel station used to fuel train engines. In addition, Triple A allegedly expanded the former Navy scrap yard area (IR-04, also known as Triple A Site 3) to include a portion of IR-72 and used the scrap yard for storage of scrap metal, drums, batteries, asbestos-containing pipe lagging material, and liquid waste. Potential contaminant sources at IR-72 are:

- Solvents, petroleum hydrocarbons, and acids stored in Building 810
- Lead and copper from used batteries stored in the storage yard area west of Building 810 and at Triple A Site 3
- PCB-containing waste oil, solvents, petroleum hydrocarbons, and other liquid wastes stored in the storage yard area west of Building 810
- Scrap metal stored in the storage yard area west of Building 810 and at Triple A Site 3
- Electrical transformers that contain PCBs stored at Triple A Site 3

- Petroleum hydrocarbons near Building 811 and USTs S-801 and S-802
- Waste fuel and waste oil containing PCBs located near the Industrial Landfill (IR-01/21)

VOCs, SVOCs, and pesticides are the primary COCs in IR-72 groundwater. During recent working meetings conducted to evaluate Parcel E groundwater data gaps, additional sampling was deemed necessary to evaluate concentrations of the primary COCs. In addition, wells at IR-72 that contain petroleum hydrocarbons will be resampled and the results evaluated in the CAP.

IR-73

IR-73 covers about 1.3 acres in the southeastern portion of Parcel E. No buildings are present at IR-73. From 1986 to 1989, San Francisco Asphalt Company leased the IR-73 land area from the Navy for use as an asphalt manufacturing site. Materials stored at the site included four ASTs containing diesel fuel and asphalt stock and drums and buckets of oily liquid. Potential contaminant sources at IR-73 are petroleum hydrocarbons from ASTs, drums, and buckets. IR-73 wells that contain petroleum hydrocarbons will be resampled and the results evaluated in the CAP.

A3.3.2 Purpose of the Current Investigation

The purpose of the current investigation is to characterize existing data gaps for Parcel E IR sites, as follows:

- Collect water-level measurements from existing A- and B-aquifer wells to determine horizontal and vertical gradients
- Collect updated chemical data from existing B-aquifer wells to characterize the vertical extent of contamination on the basis of the drinking-water pathway, particularly in areas in which no Bay Mud aquitard separates the shallow A-aquifer from the underlying B-aquifer
- Collect updated chemical data from existing A-aquifer and bedrock water-bearing-zone monitoring wells to determine whether further evaluation is necessary on the basis of the drinking-water pathway

A4 PROJECT AND TASK DESCRIPTION

No change.

A4.1 PROJECT OBJECTIVES

No change.

A4.2 PROJECT MEASUREMENTS

No change.

A4.3 PROJECT QUALITY STANDARDS AND CRITERIA

No change.

A4.4 PROJECT DOCUMENTATION

No change; field forms are unchanged but are included in Appendix 1 of this QAPP addendum.

A5 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The seven-step DQO process, described in EPA QA/G-4 (1999d), was used in developing quality objectives for this project, as presented in Sections A1 and A3. The specific quality objectives and criteria for measurement data, as they are applicable to this project, are also discussed in the following sections.

A5.1 PROJECT SCOPE AND ENVIRONMENTAL MEDIA

Groundwater samples will be collected from selected monitoring wells in Parcels C, D, and E (Table 4-4 of the FSP). Samples from each site will be analyzed for the following analytes of concern: low-level CLP VOCs; low-level CLP SVOCs; low-level CLP pesticides and PCBs; CLP dissolved metals; TPH-e; TPH-p; hexavalent chromium; gross alpha and beta radioactivity; radium 226 and 228; and MNA parameters. MNA parameters include reduced metals Fe2+, Fe3+, and Mn2+, nitrate, nitrite, sulfate, dissolved oxygen, oxidation-reduction potential, chloride, total alkalinity, hydroxide alkalinity, carbonate, bicarbonate, calcium, magnesium, sodium, potassium, and TDS. Table 4-4 of the FSP identifies the analytical suite for each monitoring well; Table 8-1 of the FSP presents the corresponding groundwater monitoring schedule.

For all wells, water-level measurements will be made during each sampling event. In situ measurement of groundwater parameters, including dissolved oxygen, oxygen-reduction potential, pH, temperature, specific conductivity, and reduced metals Fe2+ will be taken during groundwater sampling. Investigation-derived waste (IDW) will be handled according to the procedures outlined in Section 4.8 of the FSP for the Phase I GDGI.

A5.2 INTENDED DATA USERS AND USES

No change.

A5.3 DATA TYPE AND QUANTITY

No change.

A5.4 ACCEPTABLE LEVEL OF CONFIDENCE IN THE DATA

No change.

A5.5 SPECIFYING PERFORMANCE CRITERIA: PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS, AND COMPARABILITY PARAMETERS

All analytical results will be assessed according to the PARCC parameters described in the following sections. Precision and accuracy goals for each analytical method are presented in Appendix 3 of this QAPP.

A5.5.1 Precision

No change.

A5.5.2 Accuracy

No change.

A5.5.3 Representativeness

No change.

A5.5.4 Completeness

No change.

A5.5.5 Comparability

No change.

A5.6 DETECTION AND QUANTITATION LIMITS

Tables of detection limits for analytes specified for the project are included in Appendix 2 of this QAPP. The instrument detection limit (IDL) is the minimum concentration of an analyte that can be distinguished from the normal electronic noise of an analytical instrument. The quantitation limit represents the lowest concentration at which an analyte can be accurately and reproducibly quantified. Contract-required detection limits (CRDL) and contract-required quantitation limits (CRQL) are the minimums that are contractually required for analyses performed by CLP contractors.

For this project, samples analyzed for metals as prescribed in the CLP SOW for inorganic analytes (EPA 1995a) will be reported as estimated values if concentrations are less than CRDLs, but greater than IDLs. Samples analyzed for organics as prescribed in the CLP SOW for organic analytes (EPA 1994c) will be reported as estimated values if concentrations are less than the CRQLs, but greater than the method detection limit (MDL). The IDL for each inorganic analyte will be given as the detection limit in the laboratory's electronic data deliverable (EDD); otherwise, the statistical evaluations may be biased by high-value non-detect results if the CRDL or CRQL is reported as the detection limit.

A6 DOCUMENTATION AND RECORDS

No change.

A6.1 SUMMARY DATA PACKAGE

No change.

A6.1.1 Organic Analysis

No change.

A6.1.2 Inorganic Analysis

No change.

A6.2 FULL DATA PACKAGE (CONTRACT LABORATORY PROGRAM AND CONTRACT LABORATORY PROGRAM-TYPE)

No change.

A6.2.1 Organic Analysis

No change.

A6.2.2 Inorganic Analysis

No change.

A6.3 DATA PACKAGE FORMAT

No change.

A6.4 DATA ARCHIVING AND RETRIEVAL

No change.

A6.4.1 Data Management Scheme

No change.

A6.4.2 Data Management Strategy

No change.

B1 MEASUREMENT AND DATA ACQUISITION

This section describes requirements for the following:

- Sampling process design (Section B2)
- Sampling method (Section B3)
- Collection, handling, and analysis of samples (Sections B4 and B5)
- QC samples and procedures (Section B6)
- Calibration and maintenance of instruments (Section B7)
- Analytical supplies and miscellaneous equipment (Section B8)

This section provides sufficient detail to evaluate whether the methods used for this project have been verified and documented.

B2 SAMPLING DESIGN (EXPERIMENTAL DESIGN)

Detailed information about the types of samples required, sampling frequencies, and sample design is presented in Sections A1 and A3. A summary of the number of samples to be collected and the analyses required for each sample can be found in Tables 4-4 and 4-5 of the accompanying FSP. The analytical methods that will be used to analyze samples are presented in Appendix 2 of this QAPP. Sampling and analysis will be conducted in accordance with the provisions of this document, the QAPP, the FSP, the FSP addendum, and the basewide HSP.

B3 SAMPLING METHODS

This discussion describes the procedures for collecting samples and includes:

- Identification of all sampling methods to be used
- Implementation requirements
- Decontamination procedures
- Materials required

B3.1 SAMPLE COLLECTION AND DECONTAMINATION

No change.

B3.2 SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

The analytical methods, type of sample container to be used for each analysis, sample volumes required, preservation requirements for all samples, and maximum holding times for sample extraction and analysis are presented in Appendix 2 of this QAPP.

B4 SAMPLE HANDLING, CUSTODY, AND SHIPPING PROCEDURES

No change.

B4.1 SAMPLE CUSTODY PROCEDURES

No change.

B4.1.1 Sample Labels

No change.

B4.1.2 Custody Seals

No change.

B4.1.3 Chain-of-Custody Records

No change.

B4.1.4 Shipping Procedures

No change.

B4.1.5 Cooler Receipt

No change.

B5 ANALYTICAL METHODS

Appendix 2 of this QAPP presents analytical methods that will be used to analyze samples collected under the HPS Phase II GDGI. The analytical methods were selected to provide data of the necessary quality to meet the DQOs for this project and to maintain the consistency and comparability of data. The data collected under the current groundwater monitoring program must be comparable to previously collected HPS groundwater data to allow evaluation of decisions identified through the DQO process (Section A1.4). To promote comparability of data with previous analytical results, CLP methods were chosen for the majority of analyses. Appendix 2 of this QAPP presents the analytical methods and corresponding detection and reporting limits. Low-level CLP methods will be used for VOCs, SVOCs, and PCBs to meet detection limits required for comparison with identified screening criteria (Table 2-2 in Appendix 2 of this QAPP). Any modifications of the analytical methods presented in Appendix 2 will be submitted to the Navy and regulatory agencies for review before use. A subcontract laboratory using methodologies approved by EPA for which it has been certified by the California Department of Health Services (DHS) through the Environmental Laboratory Accreditation Program (ELAP) and approved by the Navy will analyze the samples.

The laboratory analytical, data reporting, and validation procedures will be carried out in accordance with the provisions of the Navy Installation Restoration Chemical Data Quality Manual (Naval Facilities Engineering Service Center [NFESC] 1999) and the protocols documented in this QAPP. A minimum of 20 percent of all analytical data received from the laboratory will be subjected to full validation, as described in Section D1.2.3.3; the remaining 80 percent will undergo cursory validation, as described in Section D1.2.3.2. Subcontracted laboratories will retain a staff that possesses analytical expertise in (1) organic and inorganic analyses, (2) QA/QC procedures, (3) production of CLP and CLP-type data packages, and (4) operation and maintenance of the laboratory information management system (LIMS). The laboratory will have sufficient qualified personnel and appropriate analytical instruments available to technically and contractually carry out work required for the HPS Phase I GDGI. The contract-required quantitation and detection limits for the methods are listed in Appendix 2 of this QAPP.

Field measurements will be made by use of methods identical to those used in conducting previous events. In situ measurements of groundwater parameters (see Table 2-1 in Appendix 2 of this QAPP) will be collected with a high-precision water quality meter connected to a flow cell and down-well pump, as detailed in Section 4.3.3 of the FSP for the Phase I GDGI.

B6 QUALITY CONTROL

The primary functions of a sampling and analysis program are to obtain accurate, representative environmental samples and to provide defensible analytical data. A program for evaluating field and laboratory data was developed to achieve those goals. The quality of the field data will be assessed through the regularly scheduled collection and analysis of field QC samples. Laboratory QC samples will also be analyzed in accordance with referenced analytical method protocols to ensure that laboratory procedures and analyses are conducted properly.

The following subsections discuss the types of QC samples to be collected and analyzed for this project and their role in the assurance that project data are acceptable. Additional QC procedures are not limited to those discussed in this section. Field and laboratory personnel may implement additional procedures in accordance with specific method protocols. The following subsections discuss field QC samples, field measurement QC procedures, laboratory QC samples, and laboratory QC procedures.

B6.1 FIELD QUALITY CONTROL SAMPLES

No change.

B6.1.1 Field Duplicates

No change.

B6.1.2 Source Water Blanks

No change.

B6.1.3 Trip Blanks

No change.

B6.1.4 Equipment Rinsate Blanks

No change.

B6.2 QUALITY CONTROL PROCEDURES FOR FIELD MEASUREMENTS

No change.

B6.3 LABORATORY QUALITY CONTROL SAMPLES

Laboratory QC samples are analyzed to evaluate the quality of preparation and analysis of field samples. Laboratory QC samples are prepared and analyzed at the laboratory to assess analytical precision, accuracy, and representativeness. The types of laboratory QC samples that will be used are discussed in the following sections.

B6.3.1 Method Blanks

No change.

B6.3.2 Laboratory Control Samples or Blank Spikes

No change.

B6.3.3 Matrix Spike and Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples are analyzed to evaluate the suitability of an analytical method for a particular environmental sample matrix. A known concentration of target analytes added to an aliquot of the field sample used in preparing the MS sample. To minimize errors, the field samples will not be spiked in the field. Instead, samples will be spiked when they are prepared for analysis at the laboratory. MSs and MSDs measure the efficiency of all the steps of the analytical method in recovering target analytes from an environmental sample matrix. The percent recoveries will be calculated for each of the spiked analytes and used to evaluate analytical accuracy. The RPD between spiked samples will be calculated to evaluate precision. For inorganic analyses, a matrix duplicate is analyzed, rather than an MSD. Evaluation of precision is based on comparison of the results of duplicate and original analyses.

MS and MSD samples are analyzed at a frequency of 5 percent. An additional sample volume will be collected for MS and MSD for water samples. If the MS and MSD percent recoveries used to assess accuracy or the relative percent difference (RPD) results used to assess precision are outside the established acceptance limits, CLP and laboratory protocols specific to the method will be followed to evaluate the usability of the data. Laboratory control samples (LCS) or blank spikes, if available, will be examined to determine the effect of the out-of-control event on the reported results. Control limits for the evaluation of MS and MSD accuracy and precision are provided in Appendix 3 of this QAPP.

B6.3.4 Surrogate Standards

Surrogate standards consist of known concentrations of nontarget analytes that are added to each sample, method blank, LCS, and MS/MSD before preparation and analysis of samples for organic parameters. The surrogate standard measures the efficiency of the analytical method in recovering the target analytes from an environmental sample matrix.

Surrogate standards provide an indication of laboratory accuracy and matrix effects for every field and QC sample that is analyzed for volatile and extractable organic compounds. Surrogate compounds are used in the analysis of VOCs to monitor purge efficiency and analytical performance, while surrogates are used in the analysis of extractable organic compounds to monitor the extraction process and analytical performance.

Surrogate percent recoveries obtained from sample analysis are evaluated using CLP and laboratory control limits. Factors such as matrix interference and high concentrations of analytes may affect surrogate recoveries. The effects of the sample matrix are frequently outside the control of the laboratory and may present unique problems. Review and validation of data on the basis of specific sample results are frequently subjective and require analytical experience and the application of professional judgment.

Laboratory personnel are required to reextract (when applicable) and reanalyze samples when results for associated surrogates are outside control limits. Data from both analyses of the samples in question are reported. The data will be qualified during review. Data will be qualified as estimated for SVOC analysis if two or more surrogates from each fraction (base/neutral and acid) are outside the control limits. EPA guidelines for evaluating organic analysis provide additional evaluation criteria (EPA 1994a). Guidelines for surrogate recovery for this project are provided in Appendix 3 of this QAPP.

B6.3.5 Internal Standards

No change.

B6.4 LABORATORY CONTROL PROCEDURES

No change

B6.4.1 Method Detection Limit Studies

No change.

B6.4.2 Instrument Detection Limit Studies

No change.

B6.4.3 Sample Quantitation Limits

No change.

B6.4.4 Control Charts

No change.

B7 TESTING, INSPECTION, AND MAINTENANCE OF INSTRUMENTS AND EQUIPMENT

No change.

B7.1 MAINTENANCE OF FIELD EQUIPMENT

No change.

B7.2 CALIBRATION OF FIELD ANALYTICAL EQUIPMENT

No change.

B7.3 MAINTENANCE OF LABORATORY EQUIPMENT

No change.

B7.4 CALIBRATION OF LABORATORY ANALYTICAL EQUIPMENT

No change.

B7.4.1 Calibration Standards

No change.

B7.4.2 Corrective Action Procedures

No change.

B8 INSPECTION AND ACCEPTANCE FOR SUPPLIES AND CONSUMABLES

No change.

B9 NONDIRECT MEASUREMENTS

No change.

B9.1 FIELD DATA MANAGEMENT

No change.

B9.2 LABORATORY DATA MANAGEMENT

No change.

B9.3 TETRA TECH EM INC. DATA MANAGEMENT

No change.

C1 ASSESSMENTS AND RESPONSE ACTIONS

No change.

C1.1 PERFORMANCE, SYSTEM, AND FIELD AUDITS

No change.

C1.1.1 Performance Audits

No change.

C1.1.2 System Audits

No change.

C1.1.3 Field Audits

No change.

C1.2 CORRECTIVE ACTION PROCEDURES

No change.

C1.2.1 Field Procedures

No change.

C1.2.2 Laboratory Procedures

No change.

C1.3 REPORTS TO MANAGEMENT

No change.

C1.3.1 Daily Quality Control Reports

No change.

C1.3.2 Project Monthly Progress Report

No change.

C1.3.3 Quality Control Summary Report

No change.

D1 DATA VALIDATION AND USABILITY

No change.

D1.1 DATA REVIEW, VERIFICATION, AND VALIDATION REQUIREMENTS

No change.

D1.2 VERIFICATION AND VALIDATION METHODS

No change.

D1.2.1 Verification of Field Data

No change.

D1.2.2 Verification of Laboratory Data

No change.

D1.2.3 Validation of Analytical Data

No change.

D2 RECONCILIATION WITH DATA QUALITY OBJECTIVES

The first step of the DQO process (see Table A-2) presented the following project objectives: (1) assess the condition of all existing wells; (2) measure basewide water levels to determine the pieziometric surface at existing A- and B-aquifer wells; (3) perform additional B-aquifer characterization in Parcels C, D, and E by sampling existing and newly installed wells for hydrogeologic and chemical parameters; and (4) resample A-aquifer wells in Parcels C, D, and E for chemical parameters to characterize the existing extent of the RUs. The sampling and laboratory methods and procedures described in detail in this QAPP should provide data of sufficient quality to conduct an initial assessment of the groundwater data gaps in the study areas at HPS. The data from the Phase II activities will be evaluated and the need for additional data will be assessed for potential Phase III activities. Phase III activities may include: (1) collecting a third round of groundwater samples at Parcel C and collecting a second round of groundwater samples at Parcel E, as necessary, from existing and newly installed monitoring wells sampled during Phase II; (2) installing additional monitoring wells as the Phase II results indicate is necessary; and (3) conducting additional hydrogeologic characterization of the A- and B-aquifers and the bedrock water-bearing zone. The scope of work for the Phase III activities will be outlined in separate FSP and QAPP addenda.

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FIGURE

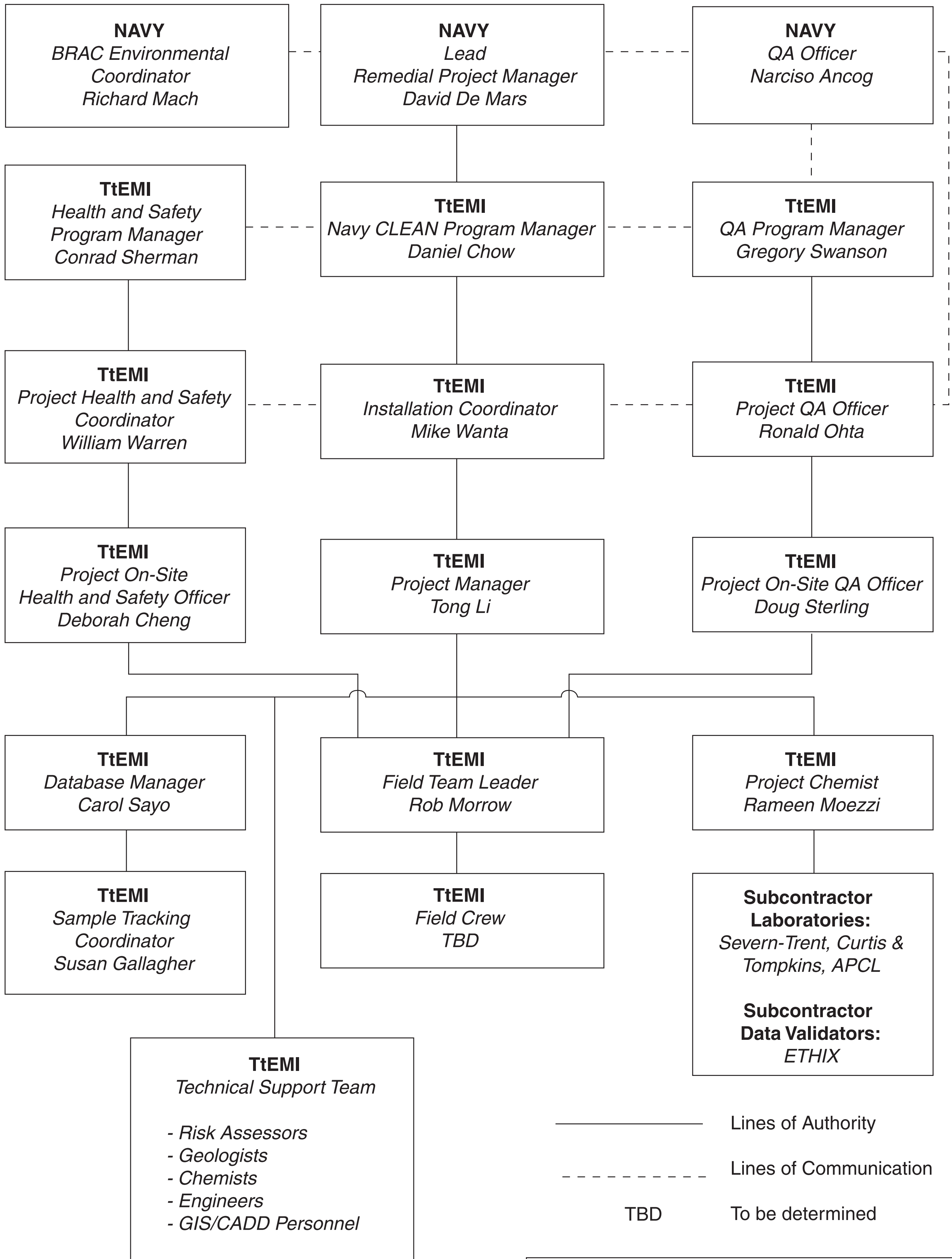


Figure A-1
Groundwater Data Gap Investigation
Organization Flowchart

APPENDIX 1

FIELD FORMS AND QUALITY CONTROL REPORTS

Field Instrument Calibration Log

CTO No.: ______________________________

Project Name: ______________________________

Instrument Type	Instrument SN	Calibration Type	Date	By

TETRA TECH EM INC.
MONITORING WELL INSPECTION FORM

Monitoring Well No.:______________ **Date:**______________

Detail the condition of the items identified below, as applicable to each individual well:

External well identification:

Internal well identification:

Concrete pad and surrounding area:

Well vault or stickup:

Well lid (if applicable):

Rubber seal (if applicable):

Lid bolts (if applicable):

Well cap:

Well lock:

Water level measuring mark and/or notch:

Was there standing water in the well vault/well stickup? Yes_____ No_____

Note any abnormalities regarding the well vault in relation to the surrounding grade:

(inspection information continued on reverse)

TETRA TECH EM INC.
MONITORING WELL INSPECTION FORM
(CONTINUED)

If necessary, using the following space, note any discrepancies between the well location portrayed on the well location map and the location of the well as identified in the field.

Location sketch:

Identify all light maintenance completed during well inspection:

Additional Comments:

Prepared by: ______________________

TETRATECH EM INC

MONITORING WELL COMPLETION RECORD

MONITORING WELL

MONITORING WELL NO.: ______
PROJECT: ______
SITE: ______
BOREHOLE NO.: ______
WELL PERMIT NO.: ______
TOC TO BOTTOM OF WELL: ______

DRILLING INFORMATION

DRILLING BEGAN:
DATE: ______ TIME: ______
WELL INSTALLATION BEGAN:
DATE: ______ TIME: ______
WELL INSTALLATION FINISHED:
DATE: ______ TIME: ______
DRILLING CO.: ______
DRILLER: ______
LICENSE: ______
DRILL RIG: ______
DRILLING METHOD:
- ☐ HOLLOW STEM AUGER
- ☐ AIR ROTARY
- ☐ OTHER: ______

DIAMETER OF AUGERS:
ID: ______ OD: ______

WELL CASING

- ☐ SCHEDULE 40 PVC
- ☐ OTHER: ______

PRODUCT: ______
MFG. BY: ______
CASING DIAMETER:
ID: ______ OD: ______
LENGTH OF CASING: ______

WELL SCREEN

- ☐ SCHEDULE 40 PVC
- ☐ OTHER: ______

PRODUCT: ______
MFG. BY: ______
CASING DIAMETER:
ID: ______ OD: ______
SLOT SIZE: ______
LENGTH OF SCREEN: ______

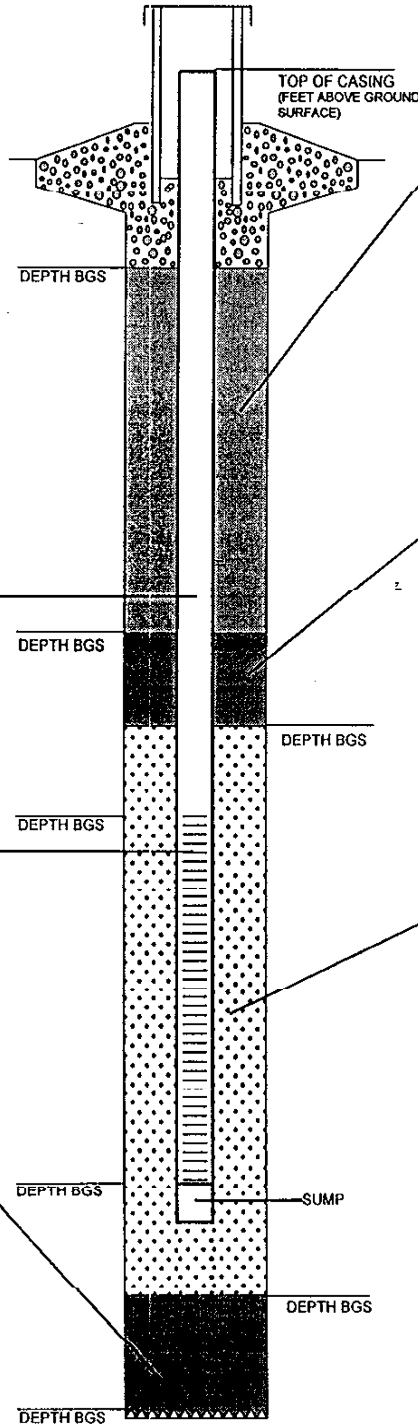
BOREHOLE BACKFILL

AMOUNT CALCULATED: ______
AMOUNT USED: ______
- ☐ BENTONITE CHIPS, SIZE: ______
- ☐ BENTONITE PELLETS, SIZE: ______
- ☐ SLURRY: ______
- ☐ FORMATION COLLAPSE: ______
- ☐ OTHER: ______

PRODUCT: ______
MFG. BY: ______
METHOD INSTALLED:
- ☐ POURED ☐ TREMIE
- ☐ OTHER: ______

SURFACE COMPLETION

- ☐ FLUSH MOUNT
- ☐ ABOVE GROUND WITH BUMPER POST
- ☐ CONCRETE ☐ ASPHALT



SURVEY INFORMATION

TOC ELEVATION: ______
GROUND SURFACE ELEVATION: ______
NORTHING: ______
EASTING: ______
DATE SURVEYED: ______
SURVEY CO.: ______

ANNULAR SEAL

VOLUME CALCULATED: ______
AMOUNT USED: ______
- ☐ GROUT FORMULA (PERCENTAGES)
  - PORTLAND CEMENT: ______
  - BENTONITE: ______
  - WATER: ______
- ☐ PREPARED MIX
  - PRODUCT: ______
  - MFG. BY: ______

METHOD INSTALLED:
- ☐ POURED ☐ TREMIE
- ☐ OTHER: ______

BENTONITE SEAL

VOLUME CALCULATED: ______
AMOUNT USED: ______
- ☐ PELLETS, SIZE: ______
- ☐ CHIPS, SIZE: ______
- ☐ OTHER: ______

PRODUCT: ______
MFG. BY: ______
METHOD INSTALLED:
- ☐ POURED ☐ TREMIE
- ☐ OTHER: ______

AMOUNT OF WATER USED: ______

FILTER PACK

- ☐ PREPACKED FILTER

VOLUME CALCULATED: ______
AMOUNT USED: ______
- ☐ SAND, SIZE: ______

PRODUCT: ______
MFG. BY: ______
METHOD INSTALLED:
- ☐ POURED ☐ TREMIE
- ☐ OTHER: ______

WATER LEVEL: ______
(BTOC AFTER WELL INSTALLATION)

CENTRALIZERS USED?

☐ YES ☐ NO;
CENTRALIZER DEPTHS: ______

LEGEND

BGS = BELOW GROUND SURFACE
BTOC = BELOW TOP OF CASING
N/A = NOT APPLICABLE
NR = NOT RECORDED
TOC = TOP OF CASING

TETRA TECH EM INC.
GROUNDWATER LEVEL MEASUREMENTS LOG

Circle type of organic vapor meter used: PID FID

Well Number	PID/FID Reading (ppm)	Time	Depth to Groundwater (ft.) (three measurements)			Depth to Bottom (ft.)	Comments
			1st	2nd	3rd		

Date: ____________

Field Staff: ____________ Field Staff Signature: ____________

Page No.: ______

Tetra Tech EM Inc.

MICROPURGING GROUNDWATER SAMPLING DATA SHEET

Page _____ of __

Date ________

Well Name ________________ | Screen Interval ________________ |
Project ________________ | Station Elevation ________ GND ____ TOC _____ | Immiscible Phases Present ☐ Yes ☐
Project No. ________________ | Static Water Level (from TOC) ________________ | Type ________________
Well Location ________________ | Well Stick Up ________________ | Measured with ________________
Sample Date ________________ | Static Elevation ________________ | PID Readings (background) ________
Sampling Personnel ________________ | Well Depth ________ MEAS ____ RPTD _____ | PID Reading (TOC) ________
________________ | Feet of Water ________________ | Wells Installed by ________________
________________ | |
Sample ID ________________ | Gallons/Foot ________________ | Installation Date ________________
Duplicate ID ________________ | Casing Volume ________________ | Development Date(s) ________________

FIELD CHEMISTRY CALIBRATIONS

Date/Time ________________ Spec. Conductance: Standard ________ µmhos/cm at 25•C Reading ________ µmhos/cm at ___

pH: pH 4.00 - ______ at ________ •C pH 7.00 - ______ at ________ •C pH 10.00 - ______ at ______ •C Slope ________

Dissolved Oxygen: D.O. Meter ______ mg/L at ______ •C PID: Calibration Gas ________ PPM ______ Span ______ Reading ______

PURGING

Time	Discharge Rate (mL/min)	Dissolved Oxygen (mg/L)	pH	Eh/ORP (mV)	Temp. (-C)	Specific Conduct. (µmhos/cm at -C)	Turbidity (NTU)	Cumulative Volume of Water Removed (Purged)		PID/OVA Reading		Depth to Water (ft)	Comments
								Gallons	Casing Vol.	Location	Value		

SAMPLE PARAMETERS

Condition of well: ________________________________

Remarks: ________________________________

FIELD EQUIPMENT

pH Meter ________________ Serial Number ________________

Spec. Cond. Meter ________________ Serial Number ________________

Pump ________________ Serial Number ________________

Water Level Meter ________________ Serial Number ________________

D.O. Meter ________________ Serial Number ________________

Filter Apparatus ________________ Filters ________________

Temperature Measure ________________

Interface Probe ________________ Serial Number ________________

PID/OVA ________________ Serial Number ________________

Field Chemistry Calibrations

Fractions ________________

____

____

Number of Bottles ________________

Sample Depth ________________

Field Notebook ________________

Sample Method ________________

____

Discharge Water Containerized ☐ Yes ☐ No

Tetra Tech EM Inc.
San Francisco Office

135 Main St. Suite 1800
San Francisco, CA 94105
415-543-4880
Fax 415-543-5480

J440

Chain of Custody Record

Page ____ of ____

PO#	Lab:
Project name:	TtEMI technical contact:	Field samplers:
Project number:	TtEMI project manager:	Field samplers' signatures:

Sample ID	Sample Description/Notes	Date	Time	Matrix	40 ml VOA	1 Liter Amber	1 Liter Poly	Brass Tube	Glass Jar	CLP VOA	CLP SVOA	CLP Pest/PCBs	CLP Metals	TPH Purgeables	TPH Extractables

No./Container Types — Analysis Required — Preservative Added

EXAMPLE

	Name (print)	Company Name	Date	Time
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				

Turnaround time/remarks:

Tetra Tech EM Inc.

Daily Quality Control Report

(Page 1 of 2)

Project Name:	Date:
Project Number:	Day:
Weather:	Wind:
Temperature:	Humidity:

Personnel on Site

Field Team Leader:

Subcontractors on Site:

Equipment on Site

Work Performed (Including Sampling)

Quality Control Activities

Health and Safety Levels and Activities

Problems Encountered / Corrective Action Taken

Tetra Tech EM Inc.

Daily Quality Control Report

Deviations from Field Work Plan

Additional Notes

Anticipated Activities for Tomorrow

Distribution:

Submitted By:

Signature

Date

Audit Report

Tetra Tech EM Inc.

Project Name: ______________________ Date of Audit: ______________________

Project No.: ______________________ Project Manager: ______________________

Audit Team Members: ______________________

Brief Description of Project:

____

____

Audit Summary:

____

____

Corrective Action Required:

____

____

Quality Improvement Opportunities:

____

____

Remarks:

____

____

Auditor Signature: ______________________ Date: ______________________

cc: TtEMI Program QA Manager

Corrective Action Request Form
(Page 1 of 2)

Tetra Tech EM Inc.

Project Name: ______________________ **Date:** ______________________

Project No.: ______________________ **Project Manager:** ______________________

Location: ____

To (Project Manager): ____

From (Audit Team Members): ____

Description Problem:

____

____

____

____

Corrective Action Required:

____

____

____

____

The above corrective action must be completed by (Date): ______________________

Acknowledgement of Receipt

____

(Signature and Date)

Corrective Action Request Form
(Page 2 of 2)

Tetra Tech EM Inc.

Corrective Action Taken:

____

____

____

____

Project Manager: ______________________________
(Signature and Date)

Audit Team Members:

Corrective Action *is / is not* satisfactory

____
(Date and Initial)

Remarks: ______________________________

QC Coordinators:

Corrective Action *is / is not* satisfactory

____
(Date and Initial)

Remarks: ______________________________

cc: Program QA Manager

APPENDIX 2

ANALYTICAL METHODS PROTOCOL

TABLE 2-1

GROUNDWATER ANALYTICAL PROTOCOL
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Analysis	Method/ Reference	Sample Volume, Container	Extra MS/MSD Volume	Preservation	Analytical Holding Time
Off-Site Laboratory Analyses – Analytes of Concern					
Volatile Organic Compounds	CLP VOC – low level	Two 40-mL VOC vials	Three 40-mL VOC vials	Sample must be collected without headspace Preserve with HCl to pH ≤ 2 and cool to 4°C	14 days (7 days if unpreserved)
Semivolatile Organic Compounds	CLP SVOC – low level	Two 1-L amber glass containers	Four 1-L amber glass containers	Unpreserved Cool to 4°C	7 days[(1)]
Pesticides/PCBs	CLP Pest/PCBs – low level	Two 1-L amber glass containers	Four 1-L amber glass containers	Unpreserved Cool to 4°C	7 days[(1)]
Metals (Dissolved)	CLP Metals	One 1-L polyethylene container	One 1-L polyethylene container	Field-filtered (to 0.45 µm) Preserve with HNO_3 to pH<2 and cool to 4°C	Hg: 28 days Others: 6 months
Hexavalent Chromium	EPA 7196A	One 500-ml polyethylene container	Two 500-ml polyethylene containers	Filtered at laboratory Unpreserved Cool to 4°C	24 hours
TPH-Purgeable (gasoline range)	EPA 8015B	Two 40-mL VOC vials	Three 40-mL VOC vials	Sample must be collected without headspace Preserve with HCl to pH ≤ 2 and cool to 4°C.	14 days (7 days if unpreserved)
TPH-Extractable (diesel and motor oil range)	EPA 8015B (silica gel cleanup optional)[2]	Two 1-L amber glass containers	Four 1-L amber glass containers	Unpreserved. Cool to 4°C.	7 days[(1)]
Gross Alpha and Beta	EPA Method 9310	One 1-L polyethylene container	One 1-L polyethylene container	Preserve with HNO_3 (nitric acid) to pH<2	180 days

TABLE 2-1

GROUNDWATER ANALYTICAL PROTOCOL
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(PAGE 2 OF 4)

Analysis	Method/ Reference	Sample Volume, Container	Extra MS/MSD Volume	Preservation	Analytical Holding Time
Off-Site Laboratory Analyses – Analytes of Concern (Continued)					
Radium 226	EPA Method 9315	One 1-L polyethylene container	One 1-L polyethylene container	Preserve with HNO_3 (nitric acid) to pH<2	180 days
Radium 228	EPA Method 9320	Two 1-L polyethylene containers	Two 1-L polyethylene containers	Preserve with HNO_3 (nitric acid) to pH<2	180 days
Nitrite-N/ Nitrate-N	EPA 353.1, MCAWW	One 500-mL polyethylene container	Two 500-mL polyethylene containers	Preserve with H_2SO_4.	48 hours
Sulfate/Chloride	EPA 300.0	One 500-mL polyethylene container	Two 500-mL polyethylene containers	Unpreserved Cool to 4°C	28 days
Total alkalinity	EPA 310.1	One 500-mL polyethylene container	Not applicable	Unpreserved Cool to 4°C	14 days
Carbonate/bicarbonate/ hydroxide alkalinity	SM 2320B, SMEWW	One 1-L polyethylene container	Not applicable	Unpreserved Cool to 4°C	14 days
TDS	EPA 160.1, MCAWW	One 1-L polyethylene container	One 1-L polyethylene container	Unpreserved Cool to 4°C	7 days

TABLE 2-1

GROUNDWATER ANALYTICAL PROTOCOL
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(PAGE 3 OF 4)

Analysis	Method/ Reference	Sample Volume, Container	Extra MS/MSD Volume	Preservation	Analytical Holding Time
Off-Site Laboratory Analyses – Analytes of Concern (Continued)					
Methane/ethane/ethene	RSK-175	Two 40-mL VOC vials	Three 40-mL VOC vials	Sample must be collected without headspace Preserve with HCl to pH ≤ 2 and cool to 4°C	14 days (7 days if unpreserved)
Salinity	SM 2520B, SMEWW	One 1-L polyethylene container	One 1-L polyethylene container	Unpreserved Cool to 4°C	28 days
Field Measurements					
Dissolved Oxygen	Water quality meter[3,4]	Not applicable	Not applicable	Limit introduction of atmospheric oxygen during measurement	Analyze immediately
Oxidation-Reduction Potential	Water quality meter[3]	Not applicable	Not applicable	Time sensitive	Analyze immediately
pH	Water quality meter[3]	Not applicable	Not applicable	Time sensitive	Analyze immediately
Specific Conductance	Water quality meter[3]	Not applicable	Not applicable	Time sensitive	Analyze immediately
Temperature	Water quality meter[3]	Not applicable	Not applicable	Time sensitive	Analyze immediately
Turbidity	Water quality meter[5]	Not applicable	Not applicable	Time sensitive	Analyze immediately
Ferrous iron (Fe^{2+})	Hach Method #8146, Pocket Colorimeter	One 1-L amber glass container (combined with manganese II)	Not applicable.	Unpreserved No headspace Filter if turbid[1] Keep out of sunlight and analyze within 1 hour of collection[2]	Analyze as soon as possible

TABLE 2-1

GROUNDWATER ANALYTICAL PROTOCOL
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(PAGE 4 OF 4)

Analysis	Method/ Reference	Sample Volume, Container	Extra MS/MSD Volume	Preservation	Analytical Holding Time
Field Measurements (Continued)					
Manganese (II) (Mn^{2+})	Hach Method #8149	One 1-L amber glass container (combined with ferrous iron)	Not applicable.	Unpreserved No headspace Filter if turbid[1] Keep out of sunlight and analyze within 1 hour of collection[2]	Analyze as soon as possible

Notes:

1 7 days to extraction, 40 days from extraction to analysis

2 Silica gel cleanup will typically be used during GDGI activities; however, silica gel cleanup will not be used at locations with extensive historic analytical results without silica gel cleanup. This decision will be made by the project chemist on a site-by-site basis.

3 Field data to be measured with MicroPurge Flowcell 4000 or equivalent.

4 Dissolved oxygen also to be initially measured with YSI 55 meter or equivalent.

5 Turbidity data to be measured with a Horiba U10 or equivalent.

Filtering: Dissolved metals samples will be filtered in the field with a 0.45 micron filter before preservation. Hexavalent chromium samples will be filtered in the laboratory.

HCl Hydrochloric acid

HNO_3 Nitric acid

MCAWW Method for Chemical Anaysis of Water and Wastes

MS/MSD Matrix spike/matrix spike duplicate. Identified volumes to be collected in addition to those for the original sample.

RSK Risk Management Policies and Procedures Manual

SMEWW Standard Method for the Examination of Water and Wastewater

TABLE 2-2

COMPARISON OF DETECTION LIMITS AND ANALYTE SCREENING CRITERIA
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Compound	MCL (mg/L)	HGAL (mg/L)	NAWQC (mg/L)	Laboratory Reporting Limit (mg/L)	LRL Below Criterion?
Volatile Organic Compounds					
1,1,1-Trichloroethane	200	NA	NA	2	Yes
1,1,2,2-Tetrachloroethane	1	NA	NA	1	Yes[1]
1,1,2-Trichloroethane	5	NA	NA	2	Yes
1,1-Dichloroethane	5	NA	NA	2	Yes
1,1-Dichloroethene	6	NA	NA	2	Yes
1,2-Dichlorobenzene	600	NA	NA	2	Yes
1,2-Dichloroethane	0.5	NA	NA	0.5	Yes[1]
1,2-Dichloropropane	5	NA	NA	2	Yes
1,4-Dichlorobenzene	5	NA	NA	2	Yes
Benzene	1	NA	NA	0.5	Yes
Carbon tetrachloride	0.5	NA	NA	0.5	Yes[1]
cis-1,2-Dichloroethene	6	NA	NA	2	Yes
Methylene chloride	5	NA	NA	2	Yes
Tetrachloroethene	5	NA	NA	2	Yes
trans-1,2-Dichloroethene	10	NA	NA	2	Yes
Trichloroethene	5	NA	NA	2	Yes
Vinyl chloride	0.5	NA	NA	0.5	Yes[1]

TABLE 2-2

COMPARISON OF DETECTION LIMITS AND ANALYTE SCREENING CRITERIA
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Compound	MCL (mg/L)	HGAL (mg/L)	NAWQC (mg/L)	Laboratory Reporting Limit (mg/L)	LRL Below Criterion?
Semivolatile Organic Compounds					
Benzo(a)pyrene	0.2	NA	NA	0.1	Yes
Bis (2-ethylhexyl) phthalate	4	NA	NA	1.0	Yes
Hexachloroethane	4.8[2]	NA	NA	1.0	Yes
Pentachlorophenol	1	NA	7.9	2.5	No[3]
Phenanthrene	6.2[2]	NA	4.6	1.0	Yes
Polychlorinated Biphenyls/Pesticides					
Aroclor-1260	0.5[4]	NA	0.19[5]	0.1	Yes
Heptachlor	0.01	NA	0.0036	0.01	Yes[1, 6]
Heptachlor epoxide	0.01	NA	0.0036	0.01	Yes[1, 6]
Metals					
Aluminum	1,000	NA	NA	50	Yes
Antimony	6	43.3	500	2.7	Yes
Arsenic	50	27.3	36	1.9	Yes
Barium	1,000	504	NA	5.6	Yes
Beryllium	4	1.40	NA	0.2	Yes
Cadmium	5	5.08	9.3	0.3	Yes
Chromium	50	15.7	NA	0.9	Yes
Chromium (VI)	109[2]	NA	50	10	Yes
Cobalt	NA	20.8	NA	2.0	Yes
Copper	1,300	28.0	3.1	1.7	Yes
Lead	15	14.4	8.1	1.0	Yes

TABLE 2-2

COMPARISON OF DETECTION LIMITS AND ANALYTE SCREENING CRITERIA
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 3 of 4)

Compound	MCL (mg/L)	HGAL (mg/L)	NAWQC (mg/L)	Laboratory Reporting Limit (mg/L)	LRL Below Criterion?
Metals (cont'd)					
Manganese	NA	8,140	NA	0.4	Yes
Mercury	2	0.60	0.94	0.1	Yes
Nickel	100	96.5	8.2	1.7	Yes
Silver	NA	7.43	0.92	1.9	Yes
Thallium	2	13.0	NA	2.7	Yes[7]
Zinc	NA	75.7	81	1.6	Yes
Total Petroleum Hydrocarbons					
TPH-p	NA	NA	NA	50	NA
TPH-e	NA	NA	NA	100	NA
Anions					
Chloride	NA	NA	NA	500	NA
Nitrate-N	NA	NA	NA	100	NA
Nitrite-N	NA	NA	NA	100	NA
Sulfate	NA	NA	NA	500	NA
Carbonate	NA	NA	NA	20,000 µg/L calcium carbonate	NA
Radioactivity					
Gross alpha radioactivity	15 pCi/L	NA	NA	5 pCi/L	Yes
Gross beta radioactivity	50 pCi/L	NA	NA	5 pCi/L	Yes
Radium 226	5 pCi/L[8]	NA	NA	1 pCi/L	Yes
Radium 228	5 pCi/L[8]	NA	NA	1 pCi/L	Yes

TABLE 2-2

COMPARISON OF DETECTION LIMITS AND ANALYTE SCREENING CRITERIA
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA
(Page 4 of 4)

Compound	MCL (mg/L)	HGAL (mg/L)	NAWQC (mg/L)	Laboratory Reporting Limit (mg/L)	LRL Below Criterion?
Other					
Total Dissolved Solids	NA	NA	NA	10,000	NA

Notes:

1 LRL is equal to the applicable criterion; since the method detection limit for each analyte is at or below the reporting limit, detected or nondetected results reported at the reporting limit should be reliable. Further, the laboratory reports results down to one-half the reporting limit, if the analyte is detected in the sample.

2 Tap water preliminary remediation goal (PRG) (US Environmental Protection Agency, Region IX, 1999)

3 LRL is lowest practical reporting limit; further, the laboratory reports results down to one-half the reporting limit, if the analyte is detected in the sample.

4 MCL for total PCBs

5 Great Lakes Water Quality Initiative, Tier II criterion

6 MCL is the applicable criteria for heptachlor and heptachlor epoxide. Further, the laboratory reports results down to one-half the reporting limit, if the analyte is detected in the sample.

7 HGAL is the applicable criterion for thallium

8 MCL for total radium 226 and 228

HGAL HPS groundwater ambient levels for metals in A-aquifer groundwater
LRL Laboratory report limit
µg/L Micrograms per liter
MCL Maximum contaminant level (from most stringent of federal or state primary MCL)
NA Not applicable
NAWQC National Ambient Water Quality Criteria for protection of saltwater aquatic life, based on continuous concentrations with a 4-day average
PCB Polychlorinated biphenyls
pCi/L Pico curies per liter
TPH-g Total petroleum hydrocarbons, purgeable (gasoline)
TPH-e Total petroleum hydrocarbons, extractables (diesel and motor oil)
WPCP Water pollution control plant

APPENDIX 3

PRECISION AND ACCURACY GOALS

TABLE 3-1

VOLATILE ORGANIC COMPOUNDS
CONTRACT LABORATORY PROGRAM METHOD
PRECISION AND ACCURACY GOALS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

Laboratory and Matrix Spike Limits

Fraction	Spike Compound	% Recovery	RPD
VOC	1,1-Dichloroethene	61-145	14
VOC	Trichlorethene	71-120	14
VOC	Chlorobenzene	75-130	13
VOC	Toluene	76-125	13
VOC	Benzene	76-127	11

Surrogate Recovery Limits

Fraction	Surrogate Compound	% Recovery
VOC	Toluene-d_8	88-110
VOC	4-Bromofluorobenzene	86-115
VOC	1,2-Dichloroethane-d_4	76-114

Notes:

RPD Relative percent difference

VOC Volatile organic compound

TABLE 3-2

SEMIVOLATILE ORGANIC COMPOUNDS
CONTRACT LABORATORY PROGRAM METHOD
PRECISION AND ACCURACY GOALS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

Laboratory and Matrix Spike Limits

Fraction	Spike Compound	% Recovery	RPD
Base/Neutral	1,2,4-Trichlorobenzene	39-98	28
Base/Neutral	Acenaphthene	46-118	31
Base/Neutral	2,4-Dinitrotoluene	24-96	38
Base/Neutral	Pyrene	26-127	31
Base/Neutral	N-Nitroso-di-n-propylamine	41-116	38
Base/Neutral	1,4-Dichlorobenzene	36-97	28
Acid	Pentachlorophenol	9-103	50
Acid	Phenol	12-110	42
Acid	2-Chlorophenol	27-123	40
Acid	4-Chloro-3-methylphenol	23-97	42
Acid	4-Nitrophenol	10-80	50

Surrogate Recovery Limits

Fraction	Surrogate Compound	% Recovery
Base/Neutral	Nitrobenzene-d_5	35-114
Base/Neutral	2-Fluorobiphenyl	43-116
Base/Neutral	p-Terphenyl-d_{14}	33-141
Base/Neutral	1,2-Dichlorobenzene-d_4	16-110
Acid	Phenol-d_5	10-110
Acid	2-Fluorophenol	21-110
Acid	2,4,6-Tribromophenol	10-123
Acid	2-Chlorophenol-d_4	33-110

Notes:

RPD Relative percent difference

TABLE 3-3

PESTICIDES AND POLYCHLORINATED BIPHENYLS
CONTRACT LABORATORY PROGRAM METHOD
PRECISION AND ACCURACY GOALS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

Laboratory and Matrix Spike Limits

Fraction	Spike Compound	% Recovery	RPD
Pest/PCB	gamma-BHC	56-123	15
Pest/PCB	Heptachlor	40-131	20
Pest/PCB	Aldrin	40-120	22
Pest/PCB	Dieldrin	52-126	18
Pest/PCB	Endrin	56-121	21
Pest/PCB	4,4'-DDT	38-127	27
Pest/PCB	Aroclor-1260	50-150	50

Surrogate Recovery Limits

Fraction	Surrogate Compound	% Recovery
Pest/PCB	Tetrachloro-m-xylene	30-150
Pest/PCB	Decachlorobiphenyl	30-150

Notes:

PCB Polychlorinated biphenyl

RPD Relative Percent difference

TABLE 3-4

MISCELLANEOUS ORGANIC ANALYSES
PRECISION AND ACCURACY GOALS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA

		Laboratory / Matrix Spike		Surrogates
Analyses	**Method**	**% Recovery**	**RPD**	**% Recovery**
Total Petroleum Hydrocarbons-Purgeable	EPA 8015B	70-130	30	75-125
Total Petroleum Hydrocarbons-Extractable	EPA 8015B (silica gel cleanup optional*)	50-150	50	60-140

Notes:

* Silica gel cleanup will typically be used during GDGI activities; however, silica gel cleanup will not be used at locations with extensive historic analytical results without silica gel cleanup. This decision will be made by the project chemist on a site-by-site basis.

EPA U.S. Environmental Protection Agency

RPD Relative percent difference

TABLE 3-5

INORGANIC ANALYSES
PRECISION AND ACCURACY GOALS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA
(Page 1 of 1)

Analyses	Method	% Recovery[a]	RPD[b]
Metals, Dissolved	CLP SOW	75-125	20
Hexavalent Chromium	EPA 7196A	75-125	20
Anions: Chloride, Nitrate-N, Nitrite-N, Sulfate	EPA 300.0	75-125	20
Carbonate	SM 2320	NA	10
Total Dissolved Solids	EPA 160.1	75-125	20

Notes:

CLP Contract Laboratory Program
EPA U.S. Environmental Protection Agency
NA Not applicable
RPD Relative percent difference
SM Standard Methods for the Examination of Water and Wastewater
SOW Statement of work

a Percent recovery control limit is based on spiked sample
b Relative percent difference control limit is based on duplicate sample

TABLE 3-6

RADIOACTIVITY ANALYSES
PRECISION AND ACCURACY GOALS
PHASE II GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA
(Page 1 of 1)

Laboratory and Matrix Duplicate Limits

Analyses	Method	% Recovery	RPD
Gross Alpha and Gross Beta Radioactivity	EPA Method 9310	70-130	20
Radium 226	EPA Method 9315	75-125	20
Radium 228	EPA Method 9320	65-135	20

Notes:

EPA U.S. Environmental Protection Agency
RPD Relative percent difference

APPENDIX C

STANDARD OPERATING PROCEDURES – TETRA TECH EM INC.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GENERAL EQUIPMENT DECONTAMINATION

SOP NO. 002

REVISION NO. 2

Last Reviewed: December 1999

RRiesing
Quality Assurance Approved

February 2, 1993
Date

1.0 BACKGROUND

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

1.2 SCOPE

This SOP applies to decontaminating general nondisposable field equipment. To prevent contamination of samples, all sampling equipment must be thoroughly cleaned prior to each use.

1.3 DEFINITIONS

Alconox: Nonphosphate soap

1.4 REFERENCES

U.S. Environmental Protection Agency (EPA). 1992. "RCRA Ground-Water Monitoring: Draft Technical Guidance. Office of Solid Waste. Washington, DC. EPA/530-R-93-001. November.

EPA. 1994. "Sampling Equipment Decontamination." Environmental Response Team SOP #2006 (Rev. #0.0, 08/11/94). On-Line Address: http://204.46.140.12/media_resrcs/media_resrcs.asp?Child1=

1.5 REQUIREMENTS AND RESOURCES

The equipment required to conduct decontamination is as follows:

- Scrub brushes
- Large wash tubs or buckets
- Squirt bottles

- Alconox
- Tap water
- Distilled water
- Plastic sheeting
- Aluminum foil
- Methanol or hexane
- Dilute (0.1 N) nitric acid

2.0 PROCEDURE

The procedures below discuss decontamination of personal protective equipment (PPE), drilling and monitoring well installation equipment, borehole soil sampling equipment, water level measurement equipment, and general sampling equipment.

2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off-site or to clean areas. All used disposable protective clothing, such as Tyvek coveralls, gloves, and booties, will be containerized for later disposal. Decontamination water will be containerized in 55-gallon drums.

Personnel decontamination procedures will be as follows:

1. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.

2. Wash outer gloves in Liquinox or Alconox solution and rinse in clean water. Remove outer gloves and place into plastic bag for disposal.

3. Remove Tyvek or coveralls. Containerize Tyvek for disposal and place coveralls in plastic bag for reuse.

4. Remove air purifying respirator (APR), if used, and place the spent filters into a plastic bag for disposal. Filters should be changed daily or sooner depending on use and application. Place respirator into a separate plastic bag after cleaning and disinfecting.

5. Remove disposable gloves and place them in plastic bag for disposal.

6. Thoroughly wash hands and face in clean water and soap.

2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling equipment should be decontaminated at a designated location on-site before drilling operations begin, between borings, and at completion of the project.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they should be steam cleaned on-site prior to placement downhole. The drilling subcontractor will typically furnish the steam cleaner and water.

After cleaning the drilling equipment, field personnel should place the drilling equipment, well casing and screens, and any other equipment that will go into the hole on clean polyethylene sheeting.

The drilling auger, bits, drill pipe, temporary casing, surface casing, and other equipment should be decontaminated by the drilling subcontractor by hosing down with a steam cleaner until thoroughly clean. Drill bits and tools that still exhibit particles of soil after the first washing should be scrubbed with a wire brush and then rinsed again with a high-pressure steam rinse.

All wastewater from decontamination procedures should be containerized.

2.3 BOREHOLE SOIL SAMPLING EQUIPMENT DECONTAMINATION

The soil sampling equipment should be decontaminated after each sample as follows:

1. Prior to sampling, scrub the split-barrel sampler and sampling tools in a bucket using a stiff, long bristle brush and Liquinox or Alconox solution.
2. Steam clean the sampling equipment over the rinsate tub and allow to air dry.
3. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
4. Containerize all water and rinsate.

5. Decontaminate all pipe placed down the hole as described for drilling equipment.

2.4 WATER LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION

Field personnel should decontaminate the well sounder and interface probe before inserting and after removing them from each well. The following decontamination procedures should be used:

1. Wipe the sounding cable with a disposable soap-impregnated cloth or paper towel.

2. Rinse with deionized organic-free water.

2.5 GENERAL SAMPLING EQUIPMENT DECONTAMINATION

All nondisposable sampling equipment should be decontaminated using the following procedures:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.

2. Maintain the same level of protection as was used for sampling.

3. To decontaminate a piece of equipment, use an Alconox wash; a tap water wash; a solvent (methanol or hexane) rinse, if applicable or dilute (0.1 N) nitric acid rinse, if applicable; a distilled water rinse; and air drying. Use a solvent (methanol or hexane) rinse for grossly contaminated equipment (for example, equipment that is not readily cleaned by the Alconox wash). The dilute nitric acid rinse may be used if metals are the analyte of concern.

4. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.

5. Containerize all water and rinsate.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GROUNDWATER SAMPLING

SOP NO. 010

REVISION NO. 3

Last Reviewed: March 2000

Quality Assurance Approved

February 19, 1993

Date

1.0 BACKGROUND

Groundwater sampling may be required for a variety of reasons, such as examining potable or industrial water supplies, checking for and tracking contaminant plume movement in the vicinity of a land disposal or spill site, Resource Conservation and Recovery Act (RCRA) compliance monitoring, or examining a site where historical information is minimal or non-existent, but where groundwater may be contaminated.

Groundwater is usually sampled through an in-place well, either temporarily or permanently installed. However, it can also be sampled anywhere groundwater is present, such as a pit or a dug or drilled hole.

Occasionally, a well will not be in the preferred location to obtain the sample needed (for example, to track a contaminant plume). In such a case, a temporary or permanent well will have to be installed. An experienced and knowledgeable person, preferably a hydrogeologist, will need to locate the well and supervise its installation so that the samples ultimately collected will be representative of the groundwater. SOP No. 020 (Monitoring Well Installation) provides guidance for installing new monitoring wells.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for determining the quality of groundwater entering, leaving, or affected by site activities through groundwater sampling. The samples are obtained by retrieving water from a well screened in the aquifer(s) underlying a site.

1.2 SCOPE

This SOP provides general guidance for groundwater sampling activities conducted in the field. SOP No. 015 (Groundwater Sample Collection Using Micropurge Technology) provides additional specific guidance for using low flow methods to collect groundwater samples.

1.3 DEFINITIONS

Bailer: A cylindrical sampling device with valves on either end used to extract water from a well. Bailers are usually constructed of an inert material such as stainless steel or polytetrafluoroethylene (Teflon). The bailer is lowered and raised by means of a cable that may be cleaned and reused, or by disposable rope.

Electrical Water Level Indicator: An electrical device that has a light or sound alarm connected to an open circuit used to determine the depth to liquid. The circuit is closed when the probe intersects a conducting liquid. The wire used to raise and lower the probe is usually graduated.

Immiscible Phase: Liquid phases that cannot be uniformly mixed or blended with water. Heavy immiscible phases sink, and light immiscible phases float on water.

Interface Probe: An electrical probe that determines the distance from the surface to air/water, air/immiscible, or immiscible/water interfaces.

Purge Volume: The volume of water that needs to be removed from the well prior to sampling to ensure that the sample collected is representative of the groundwater.

Riser Pipe: The length of well casing above the ground surface.

Total Well Depth: The distance from the ground surface to the bottom of the well.

Water Level: The level of water in a well, measured as depth to water or as elevation of water, relative to a reference mark or datum.

1.4 REFERENCES

U.S. Department of Energy. 1985. "Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells: Second Edition." Edited by N. Korte and P. Kearl. Technical Measurements Center, Grand Junction Projects Office. GJ/TMC-08.

U.S. Environmental Protection Agency (EPA). 1977. "Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities." EPA-530/SW-611. August.

EPA. 1984. "Sampling at Hazardous Materials Incidents." EPA Hazardous Response Support Division, Cincinnati, 1984.

EPA. 1995. "Groundwater Well Sampling." Environmental Response Team SOP #2007 (Rev. #0.0, 01/26/95). On-Line Address: http://204.46.140.12/media_resrcs/media_resrcs.asp?Child1=

U.S. Geological Survey. 1984. "National Handbook of Recommended Methods for Water-Data Acquisition" Reston, Virginia.

1.5 REQUIREMENTS AND RESOURCES

There are various options available to obtain groundwater samples. The procedures are outlined in the following section. The equipment needed to accomplish these procedures includes the following:

- Organic vapor detector with a flame ionization detector (FID) or a photoionization detector (PID)
- Pipe wrench
- Electrical water level indicator or interface probe
- Steel tape with heavy weight
- Purging device (type needed depends on well depth, casing diameter, and type of sample desired; see sampling devices below)
- Sampling device (type needed depends upon depth to water and type of sample desired)
  - Teflon bailer
  - Stainless steel bailer
  - Teflon bladder pump
  - Stainless steel submersible (nonoil-bearing) pump

  - Existing dedicated equipment
  - Peristaltic pump

- Sample containers

- Wastewater containers

- Field logbook

- Stopwatch

Additional equipment is required to complete measurement of field parameters (for example, pH, specific conductance, and temperature) of the groundwater in the well.

2.0 PROCEDURE

Prior to sampling, a site-specific sampling plan should be developed. The plan should take into consideration the site characteristics and should include:

- Specific repeatable well measurement techniques and reference points for determining the depth to water and the depth to the bottom of the well

- Specific method of purging and selection of purging equipment

- Specific methods and equipment for measurements of field parameters

- Specific method of sample collection and the sampling equipment that will be used

- Specific parameters for which samples will be analyzed

- Order in which sample bottles will be filled, based on the analytical parameters

The following sections discuss procedures for approaching the well, establishing a sample preparation area, making preliminary well measurements, purging the well, and collecting samples.

2.1 APPROACHING THE WELL

In general, all wells should be assumed to pose a health and safety risk until field measurements indicate otherwise. Approach wells from the upwind side. Record well appearance and general condition of the protective casing, surface seal, and surrounding area in the logbook.

Once at the well, the lead person should systematically use the organic vapor detector to survey the immediate area around the well (from the breathing zone to the top of the casing to the ground). If elevated FID and PID meter readings are encountered, retreat to a safe area and instruct the sampling team to put on the appropriate level of personal protective equipment (PPE). See SOP No. 003 (Organic Vapor Air Monitoring) for additional guidance.

Upon opening the well casing, the lead person should systematically survey inside the well casing, above the well casing in the breathing zone and the immediate area around the well. If elevated FID or PID meter readings in the breathing zone are encountered (see health and safety plan for action levels), retreat and put on appropriate PPE. It is important to remember that action levels are based on readings in the breathing zone, not within the well casing. Representative organic vapor detector readings should be recorded in the logbook.

2.2 ESTABLISHING A SAMPLE PREPARATION AREA

The sample preparation area is generally located upwind or to either side of the well. If elevated readings are encountered using an organic vapor detector, this area should be taped off and the sample preparation area should be located upwind where ambient readings are found.

2.3 MAKING PRELIMINARY WELL MEASUREMENTS

Several preliminary well measurements should be made prior to initiating sampling of the well. These include determining water level and total well depth measurements, determining the presence of immiscible phases, and calculating purge volumes. All preliminary measurements will be recorded in the logbook as they are determined. SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement) provides additional information concerning these preliminary measurements.

2.3.1 Water Level and Total Well Depth Measurements

Tetra Tech typically uses an electric water level indicator for water level measurements. This device sounds an alarm or illuminates a light when the measuring probe touches the water surface, thus closing an electrical circuit. The electric cable supporting the probe is usually graduated in feet and can be read at the well site directly. The remaining fraction is measured with a steel tape graduated to 0.01 foot. The distance between the static water level and the marked or notched location at the top of the riser pipe is measured. The height of the riser pipe above ground surface, as obtained from well location survey data, is then subtracted from the total reading to give the depth to static water. To improve accuracy, three separate readings should be made, and the values averaged. This helps to eliminate any errors due to kinks or bends in the cables, which may change in length when the water level indicator is raised and lowered.

The total well depth can be measured by using a steel tape with a heavy weight attached to the end. The tape is lowered into the well until resistance is met, indicating that the weight has reached the bottom of the well. The total well depth is then read directly from the steel tape to the 0.01-foot fraction. The distance between the bottom of the well and the marked or notched location on the riser pipe is measured. The height of the riser pipe above the ground surface, as obtained from well survey data, is then subtracted from the total reading to give the depth to the bottom of the well. To improve accuracy, three separate readings should be made, and the readings averaged.

2.3.2 Determining If Immiscible Phases Are Present

If immiscible phases (organic floaters or sinkers) are present, the following measurement activities should be undertaken. Organic liquids are measured by lowering an interface probe slowly to the surface of the liquid in the well. When the audible alarm sounds, record the depth. If the alarm is continuous, a floating immiscible layer has been detected. To determine the thickness of this layer, continue lowering the probe until the alarm changes to an oscillating signal. The oscillating signal indicates that the probe has detected an aqueous layer. Record this depth as the depth to water and determine the thickness and the volume of the immiscible layer.

Continue lowering the probe into the well to determine if dense immiscible phases (sinkers) are present. If the alarm signal changes from oscillating to a continuous sound, a heavier immiscible layer has been detected; record this depth.

Continue lowering the probe to the bottom of the well and record the total depth. Separate total depth measurements with a steel tape are not necessary when using an interface probe. Calculate and record the sinker phase volume and total water volume in the well. A chart is provided in Table 1 to assist in these calculations. If immiscible phases are present, immediately refer to Section 2.5.3 or 2.5.4 of this SOP.

2.3.3 Determination of Purging Volume

If the presence of floaters or sinkers does not need to be determined, determine the depth to water and the total depth of the well as described in Section 2.3.1. Once these measurements have been made and recorded, use Table 1 to calculate the total volume of water in the well. Multiply this volume by the purging factor to determine purging volume. The minimum purging factor is typically three casing volumes but may be superseded by site-specific program requirements, individual well yield characteristics, or stabilization of field parameters measured during purging. Field parameters (for example, pH, specific conductance, and temperature) should be measured prior to purging and after each well volume. All field parameter data should be recorded in the field logbook. SOPs No. 011 (Field Measurement of Water Temperature), 012 (Field Measurement of pH), and 013 (Field Measurement of Specific Conductance) include more detailed procedures for determining these field parameters.

In Table 1, the volume of water in a 1-foot section of a 2-inch-diameter well is 0.163 gallon. This chart can easily be used for any water depth by multiplying all the values in Table 1 by the L value (depth, in feet, of water in the well). The volume of water in the well is based on the following formula:

$$V = \frac{\pi \times D^2}{4} \times L$$

where

V = volume of water in the well (cubic feet)

D = inside diameter of the well (feet)

L = depth of water in the well (feet)

2.4 PURGING THE WELL

Currently, Tetra Tech standards allow for six options for purging wells:

1. Teflon bailers
2. Stainless steel bailers
3. Teflon bladder pumps
4. Stainless steel submersible (nonoil-bearing) pumps
5. Existing dedicated equipment
6. Peristaltic pumps (these devices are for shallow wells only)

As previously stated, the minimum purging volume is typically three casing volumes. Exceptions to this standard may be made in the case of low-yield wells. When purging low-yield wells, purge the well once to dryness. Samples should be collected as soon as the well recovers. When the time required for full recovery exceeds 3 hours, samples should be collected as soon as sufficient groundwater volume is available.

The well should be purged until measured field parameters have stabilized. If any field parameter has not stabilized, additional purging should be performed. To be considered stable, field parameters should change by no more than the tolerance levels listed on Table 2 between each well volume purged.

At no time should the purging rate be high enough to cause the groundwater to cascade back into the well, resulting in excessive aeration and potential stripping of volatile constituents.

The actual volume of purged water can be measured using several acceptable methods:

- When bailers are used, the actual volume of each bailer's contents can be measured using a calibrated bucket.
- If a pump is used for purging, the pump rate can be determined by using a bucket of known volume, stopwatch, and the duration of pumping time necessary to purge the known volume.

2.5 SAMPLE COLLECTION

This section first describes general groundwater sample collection procedures. This section also describes procedures for collecting groundwater samples for volatile organic analysis (VOA) and for collecting samples when light or heavy immiscible layers are present in a monitoring well. Samples of light and heavy immiscible layers should be collected before the well is purged.

2.5.1 General Groundwater Sampling Procedures

The technique used to withdraw a groundwater sample from a well should be selected based on the parameters for which the sample will be analyzed. To ensure that the groundwater samples are representative, it is important to avoid physically altering or chemically contaminating the sample during collection, withdrawal, or containerization. If the samples are to be analyzed for volatile organic compounds, it is critical that air does not become entrained in the water column.

Acceptable sampling devices for all parameters are double check valve stainless steel or Teflon bailers, bladder pumps, low-flow positive displacement pumps, or for shallow wells, peristaltic pumps. Additional measurements of field parameters should be performed at the time of sampling.

In some cases, it may become necessary to use dedicated equipment already in the well to collect samples. This is particularly true of high volume, deep wells (>150 feet) where bladder pumps are ineffective and bailing is impractical. If existing equipment must be used, however, determine the make and model of the pump and obtain information on component construction materials from the manufacturer or facility representatives. If an existing pump is to be used for sampling, make sure the flow volume can be reduced so that a reliable VOA sample can be taken. Record the specific port, tap, or valve from which the sample is collected.

General sampling procedures include the following:

- Clean sampling equipment should not be placed directly on the ground. Use a plastic drop cloth or feed line from clean reels. Never place contaminated lines back on reels.
- Check the operation of the bailer check valve assemblies to confirm free operation.
- If the bailer cable is to be decontaminated and reused, it must be made of Teflon-coated stainless steel.
- Lower sampling equipment slowly into the well to avoid degassing the water and damaging the equipment.
- Pump flow rates should be adjusted to eliminate intermittent or pulsed flow. The settings should be determined during the purging operations.
- A separate sample volume should be collected to measure necessary field parameters. Samples should be collected and containerized in the order of the parameters' volatilization sensitivity. Table 3 lists the preferred collection order for common groundwater parameters.

Intermediate containers should never be used to prepare VOA samples and should be avoided for all parameters in general. All VOA containers should be filled at a single sampling point or from a single bailer volume.

2.5.2 Collection of Volatile Organics Samples

This section discusses the collection of samples for VOA using either a bailer or bladder pump in detail. Other pumps (such as positive displacement or peristaltic) can be used. The following factors are critical to the collection of representative samples for VOA: ensuring that no air has become entrained in the water column, low pump flow rates (less than 100 milliliter [mL] per minute, if possible), and avoiding flow surges.

2.5.2.1 Collection with Bailers

Samples for VOA should be collected from the first bailer removed from the well after purging. The most effective means requires two people. One person should retrieve the bailer from the well and pour its contents into the appropriate number of 40-mL VOA vials held by the second person. Cap each vial and invert it. If a bubble exists, unscrew the cap and add more water, or discard and repeat. The sample should be transferred from the bailer to the sample container in a manner that will limit the amount of agitation in order to reduce the loss of volatile organics from the sample.

Always fill VOA vials from a single bailer volume. If the bailer is refilled, samples cannot be considered duplicates or splits.

2.5.2.2 Collection with a Bladder Pump (Well Wizard)

To successfully perform VOA sampling with a Well Wizard bladder pump, the following steps must be completed:

1. Following manufacturer's directions, activate the pump. Full water flow from the discharge tubing will begin after 5 to 15 pumping cycles. These initial pumping cycles are required to purge air from the pump and discharge tubing. The discharge and recharge settings must be manually set and adjusted to pump at optimum flow rates. To activate the bladder, it is best to set the initial cycle at long discharge and recharge rates.

2. Reduce water flow rate for VOA sample collection. To reduce the water flow rate, turn the throttle control valve (located on the left side of the Well Wizard pump control panel) counterclockwise.

3. Collect VOA sample from discharge tubing. VOA vials must be placed beneath the discharge tubing while avoiding direct contact between the vials and the tubing. Never place tubing past the mouth of the VOA vial. The pump throttle control must be turned as necessary to maintain a trickle of water in order to obtain a meniscus in the vial.

4. Continue with non-VOA sampling. Increase pump flow rate by turning the throttle control knob clockwise.

2.5.3 Collection of Light Immiscible Floaters

The approach used when collecting floaters depends on the depth to the floating layer and the thickness of that layer. If the thickness of the floater is 2 feet or greater, a bottom-filling valve bailer should be used. Slowly lower the bailer until contact is made with the floater surface, and lower the bailer to a depth less than that of the floater/water interface depth as determined by preliminary measurements with the interface probe.

When the thickness of the floating layer is less than 2 feet, and the depth to the surface of the floating layer is less than 15 feet, a peristaltic pump can be used to extract a sample.

When the thickness of the floating layer, however, is less than 2 feet and the depth to the surface of the floating layer is beyond the effective “lift” of a peristaltic pump (greater than 25 feet), a bailer can be modified to allow filling from the top only (an acceptable alternative is to use a top- loading Teflon or stainless-steel bailer). Disassemble the bailer’s bottom check valve and insert a piece of 2-inch diameter Teflon sheet between the ball and ball seat. This will seal off the bottom valve. Remove the ball from the top check valve, thus allowing the sample to enter from the top. To overcome buoyancy when the bailer is lowered into the floater, place a length of one-inch stainless steel pipe on the retrieval line above the bailer (this pipe may have to be notched to allow sample entry if the pipe remains within the top of the bailer). As an alternative, use a top-loading stainless-steel bailer. Lower the device, carefully measuring the depth to the surface of the floating layer, until the top of the bailer is level with the top of the floating layer. Lower the bailer an additional one-half thickness of the floating layer and collect the sample. This technique is the most effective method of collection if the floating layer is only a few inches thick.

2.5.4 Collection of Heavy Immiscible Sinkers

The best method for collection of sinkers is use of a double check valve bailer. The key to collection is controlled, slow lowering and raising of the bailer to and from the bottom of the well. Collection methods are equivalent to those described in Section 2.5.3 above.

TABLE 1

LIQUID VOLUME IN A 1-FOOT SECTION OF WELL CASING

Well Casing Inside Diameter (D) (inches)	Volume of Liquid in 1-Foot Well Section (gallons) V= 0.0408 (D^2)
1	0.041
1.5	0.092
2	0.163
3	0.367
4	0.653

TABLE 2

FIELD MEASUREMENT TOLERANCE LEVELS

Field Parameter	Tolerance Level
pH	0.1 pH unit
Specific Conductance	10 percent relative percent difference (RPD)[a]
Temperature	1 °C

Note:

[a] RPD can be determined as follows:

$$\text{RPD} = \frac{(\text{Measurement 1} - \text{Measurement 2}) \times 100}{(\text{Measurement 1} + \text{Measurement 2}) / 2}$$

TABLE 3

ORDER OF PREFERRED SAMPLE COLLECTION

1. VOA
2. Purgeable organic halogens (POX)
3. Total organic halogens (TOX)
4. Cyanide
5. Extractable organics
6. Purgeable organic carbon (POC)
7. Total metals
8. Dissolved metals
9. Total organic carbon (TOC)
10. Phenols
11. Sulfate and chloride
12. Nitrate and ammonia
13. Radionuclides

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

STATIC WATER LEVEL, TOTAL WELL DEPTH, AND IMMISCIBLE LAYER MEASUREMENT

SOP NO. 014

REVISION NO. 0

Last Reviewed: December 1999

RKiesing

July 20, 1994

Quality Assurance Approved

Date

1.0 BACKGROUND

Measurement of static water level, total well depth, and any immiscible layers is necessary before a well can be sampled and groundwater flow direction can be determined. If an immiscible layer is present, its depth and thickness must be determined. In addition, the static water level and total depth of a monitoring well are needed to determine a purging volume.

1.1 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide guidelines for field personnel measuring static water levels and total water depths of monitoring wells or piezometers. This SOP also provides guidelines for measuring immiscible layers in such wells.

1.2 SCOPE

This SOP describes the methodologies for measuring static water level, total well depth, and immiscible layer depth and thickness.

1.3 DEFINITIONS

To clarify the methodologies presented in this SOP, the following definitions are presented:

Electrical Water Level Indicator: An electrical probe used to determine the depth to fluid. The probe has a light or sound alarm connected to an open circuit. The circuit is closed and the alarm is activated when the probe contacts a conducting fluid such as water.

Immiscible Layer: A liquid phase that cannot be uniformly mixed or blended with water. Heavy immiscible phases sink in water; light immiscible phases float on water.

Interface Probe: An electrical probe used to determine the thicknesses of light or dense immiscible layers in the water column of a monitoring well.

Ionization Detector: A photoionization detector (PID) or a flame ionization detector (FID) is used to measure the level of volatile organic compounds in the gaseous phase. These units are generally not compound-specific and thus measure only total volatile organic compounds. The PID generally cannot detect as complete a range of compounds as the FID. This difference is the result of the relative ionization energies of the two detectors. Most PIDs cannot detect methane, but FIDs can. The HNu and Microtip are examples of PIDs; the Foxboro organic vapor analyzer (OVA) is an example of an FID.

Static Water Level: The level of water in a monitoring well or piezometer. This level can be measured as the depth to water or as the elevation of water relative to a reference mark or datum.

Total Well Depth: The distance from the ground surface to the bottom of a monitoring well or piezometer

1.4 REFERENCES

SOP No. 002, General Equipment Decontamination

U.S. Environmental Protection Agency. 1994. “Water Level Measurement.” Environmental Response Team SOP #2043 (Rev. #0.0, 10/03/94). On-Line Address: http://204.46.140.12/media_resrcs/media_resrcs.asp?Child1=

1.5 REQUIREMENTS AND RESOURCES

The equipment required for measuring static water levels, total well depths, and immiscible layers is as follows:

- Electrical water level indicator
- Interface probe
- PID or FID

2.0 PROCEDURES

This section provides general guidance followed by specific procedures for static water level, total well depth, and immiscible layer measurement.

Techniques for measuring depth to water and depth to the bottom of a monitoring well should be identified in the planning stage of field work. Also at this stage, measuring devices should be chosen, and an individual should be assigned to take and record measurements.

All measurement instruments should be decontaminated before and after use and between measurement locations. Refer to SOP No. 002, General Equipment Decontamination.

Before initiating any measuring activities, the ambient air at a monitoring well head should be monitored for possible emissions of volatile organic compounds. To accomplish this monitoring, a PID or an FID should be used. The health and safety plan for on-site activities should provide action levels and the rationale for selection of either detector.

Appropriate respiratory protection equipment should be worn by the sampling team. Wells should be approached from the upwind side. When opening the monitoring well, the sampling team should systematically survey the inside of the well casing, the area from the casing to the ground, the area from above the well casing to the breathing zone, and the area around the well. Readings for comparison to action levels should be taken not within the well casing but in the breathing zone. If PID or FID readings of volatile organic compounds are above action levels, the sampling team should retreat to a safe area and put on appropriate safety gear. The site-specific health and safety plan should be consulted for action levels.

2.1 STATIC WATER LEVEL MEASUREMENT

The procedure described below should be followed to measure the static water level in a monitoring well or piezometer.

An electric water level indicator is typically used for static water level measurement. The electrical probe of the indicator should be lowered into the monitoring well until the light or sound alarm is activated, indicating that the probe has touched the water surface. The static water level should then be read directly from the indicator to the 0.01-foot fraction. If the monitoring well top is not flush with the ground surface, the distance between the static water level and the top of the riser pipe should be measured; the height of the riser pipe above ground surface should then be subtracted from the first measurement to determine the depth to static water below ground surface. If surveyed elevations are available, they should be used to establish the water level elevation. To ensure measurement accuracy, the probe should be left hanging above the water surface in the monitoring well; a series of three readings should be taken, and the values should be averaged. The measurement date and time, individual readings, and the average of the readings should be recorded in a field logbook.

2.2 TOTAL WELL DEPTH MEASUREMENT

The procedure described below should be followed to measure total well depth in a monitoring well or piezometer.

Total well depth measurement can be performed also using an electric water level indicator. The electrical probe of the indicator should be lowered into the monitoring well until resistance is met, indicating that the probe has reached the bottom of the well. The total well depth should then be read directly from the indicator to the 0.01-foot fraction. If the monitoring well top is not flush with the ground surface, the distance between the bottom of the well and the top of the riser pipe should be measured; the height of the riser pipe above ground surface should then be subtracted from the first measurement to determine the depth from ground surface to the bottom of the well. To ensure measurement accuracy, the probe should be left hanging above the water surface in the monitoring well; a series of three readings should be taken, and the values should be averaged. The measurement date and time, individual readings, and the average of the readings should be recorded in a field logbook.

2.3 IMMISCIBLE LAYER DETECTION AND MEASUREMENT

The procedure described below should be followed to detect and measure an immiscible layer in a monitoring well.

A light immiscible layer in a monitoring well can be detected by slowly lowering an interface probe to the surface of the water in the well. When the audible alarm sounds, the depth of the probe should be recorded. If the alarm is continuous, a light immiscible layer has been detected. To measure the thickness of this layer, the probe should then be lowered until the alarm changes to an oscillating signal. The oscillating alarm indicates that the probe has reached a water layer. The probe depth at the time the alarm begins oscillating should be recorded as the depth to water. The thickness of the light immiscible layer should then be determined by subtracting the depth at which a continuous alarm occurred from the depth at which the alarm began to oscillate. To ensure measurement accuracy, the interface probe should be left hanging above the water surface in the monitoring well; a series of three readings should be taken, and the depths and thicknesses measured should be averaged. The measurement date and time, individual readings for depth and thickness, and average values for depth and thickness should be recorded in a field logbook.

To determine whether a dense immiscible layer is present, the interface probe should be lowered further into the monitoring well. If the alarm changes from an oscillating to a continuous signal, a heavier immiscible layer has been detected, and the probe depth should be recorded at that point. Total well depth obtained in Section 2.2 should be used for calculating the thickness of the dense layer. The dense layer should be calculated by subtracting the depth at which the alarm became continuous from the total well depth. This procedure provides an estimate of the thickness of the dense layer in the monitoring well. To ensure measurement accuracy, the interface probe should be left hanging above the water surface in the monitoring well; a series of three readings should be taken, and the depths and thicknesses measured should be averaged. The measurement date and time, individual readings for depth and thickness, and average values for depth and thickness should be recorded in a field logbook.

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GROUNDWATER SAMPLE COLLECTION USING MICROPURGE TECHNOLOGY

SOP NO. 015

REVISION NO. 0

Last Reviewed: January 2000

R Riesing

Quality Assurance Approved

April 7, 1998

Date

1.0 BACKGROUND

Groundwater sample collection is an integral part of site characterization at many contaminant release investigation sites. Often, a requirement of groundwater contaminant investigation is to evaluate contaminant concentrations in the aquifer. Since data quality objectives of most investigations require a laboratory setting for chemical analysis, samples must be collected from the aquifer and submitted to a laboratory for analysis. Therefore, sample collection and handling must be conducted in a manner that minimizes alteration of chemical characteristics of the groundwater.

In the past, most sample collection techniques followed federal and state guidance. Acceptable protocol included removal of water in the casing of a monitoring well (purging), followed by sample collection. The water in the casing was removed so groundwater from the formation could flow into the casing and be available for sample collection. Sample collection was commonly completed with a bailer, bladder pump, controlled flow impeller pump, or peristaltic pump. Samples were preserved during collection. Often, samples to be analyzed for metals contamination were filtered through a 0.45-micron filter prior to preservation and placement into the sample container.

Research conducted by several investigators has demonstrated that a significant component of contaminant transport occurs while the contaminant is sorbed onto colloid particles. Colloid mobility in an aquifer is a complex, aquifer-specific transport issue, and its description is beyond the scope of this Standard Operating Procedure (SOP). However, concentrations of suspended colloids have been measured during steady state conditions and during purging activities. Investigation results indicate standard purging procedures can cause a significant increase in colloid concentrations, which in turn may bias analytical results.

Micropurge sample collection provides a method of minimizing increased colloid mobilization by removing water from the well at the screened interval at a rate that preserves or minimally disrupts steady-state flow conditions in the aquifer. During micropurge sampling, groundwater is discharged from the aquifer at a rate that the aquifer will yield without creating a cone of depression around the sampled well. Research indicates that colloid mobilization will not increase above steady-state conditions during low-flow discharge. Therefore, the collected sample is more likely to represent steady-state groundwater chemistry.

1.1 PURPOSE

The purpose of this SOP is to describe the procedures to be used to collect a groundwater sample from a well using the micropurge technology. The following sections describe the equipment to be used and the methods to be followed to promote uniform sample collection techniques by field personnel that are experienced in sample collection and handling for environmental investigations.

1.2 SCOPE

This SOP applies to groundwater sampling using the micropurge technology. It is intended to be used as an alternate SOP to the general “Groundwater Sampling” SOP (SOP No. 10) that provides guidance for the general aspects of groundwater sampling.

1.3 DEFINITIONS

Colloid: Suspended particles that range in diameter from 5 nanometers to 0.2 micrometers.

Dissolved oxygen: The ratio of the concentration or mass of oxygen in water relative to the partial pressure of gaseous oxygen above the liquid which is a function of temperature, pressure, and concentration of other solutes.

Flow-through cell: A device connected to the discharge line of a groundwater purge pump that allows regular or continuous measurement of selected parameters of the water and minimizes contact between the water and air.

pH: The negative base-10 log of the hydrogen-ion activity in moles per liter.

Reduction and oxidation potential: A numerical index of the intensity of oxidizing or reducing conditions within a system, with the hydrogen-electrode potential serving as a reference point of zero volts.

Specific conductance: The reciprocal of the resistance in ohms measured between opposite faces of a centimeter cube of aqueous solution at a specified temperature.

Turbidity: A measurement of the suspended particles in a liquid that have the ability to reflect or refract part of the visible portion of the light spectrum.

1.4 REFERENCES

Puls, R. W. and M. J. Barcelona. 1996. Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. U.S. Environmental Protection Agency. Office of Research and Development. EPA/540/S-95/504. April.

1.5 REQUIREMENTS AND RESOURCES

The following equipment is required to complete micropurge sample collection :

- Water level indicator
- Adjustable flow rate pump (bladder, piston, peristaltic, or impeller)
- Discharge flow controller
- Flow-through cell
- pH probe
- Dissolved oxygen (DO) probe
- Turbidity meter
- Oxidation and reduction (Redox or Eh) probe
- Specific conductance (SC) probe (optional)
- Temperature probe (optional)
- Meter to display data for the probes
- Calibration solutions for pH, SC, turbidity, and DO probes, as necessary
- Container of known volume for flow measurement or calibrated flow meter
- Data recording and management system

2.0 PROCEDURE

The following procedures and criteria were modified from the U. S. Environmental Protection Agency guidance titled "Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures" (Puls and Barcelona 1996). This reference may be consulted for a more detailed description of micropurge sampling theory.

Micropurging is most commonly accomplished with low-discharge rate pumps, such as bladder pumps, piston pumps, controlled velocity impeller pumps, or peristaltic pumps. Bailers and high capacity submersible pumps are not considered acceptable micropurge sample collection devices. The purged water is monitored (in a flow-through cell or other constituent monitoring device) for chemical and optical parameters that indicate steady state flow conditions between the sample extraction point and the aquifer. Samples are collected when steady state conditions are indicated.

Groundwater discharge equipment may be permanently installed in the monitoring well as a dedicated system, or it can be installed in each well as needed. Most investigators agree that dedicated systems will provide the best opportunity for collecting samples most representative of steady state aquifer conditions, but the scope of a particular investigation and available investigation funds will dictate equipment selection.

2.1 EQUIPMENT CALIBRATION

Prior to sample collection, the monitoring equipment used to measure pH, Eh, DO, turbidity, and SC should be calibrated or checked according to manufacturer's directions. Typically, calibration activities are completed at the field office at the beginning of sampling activities each day. The pH meter calibration should bracket the pH range of the wells to be sampled (acidic to neutral pH range [4.00 to 7.00] or neutral to basic pH range [7.00 to 10.00]). The DO meter should be calibrated to one point (air-saturated water) or two points (air-saturated water and water devoid of all oxygen). The SC meter cannot be calibrated in the field. It is checked against a known standard (typical standards are 1, 10, and 50 millimhos per centimeter at 25EC). The offset of the measured value of the calibration standard can be used as a correction value. Similarly, the Eh probe cannot be calibrated in the field, but is checked against a known standard, such as Zobell solution. The instrument should display a millivolt (mv) value that falls within the range set by the manufacturer. Because Eh is temperature dependent, the measured value should be corrected for site-specific variance from standard temperature (25EC). The Eh probe should be replaced if the reading is not within the manufacturer's specified range. All calibration data should be recorded on the Micropurging Groundwater Sampling Data Sheet attached to this SOP or in a logbook.

2.2 WELL PURGING

The well to be sampled should be opened and groundwater in the well allowed to equilibrate to atmospheric pressure. Equilibration should be determined by measuring depth to water below the marked reference on the wellhead (typically the top of the well casing) over two or more 5-minute intervals. Equilibrium conditions exist when the measured depth to water varies by less than 0.01 foot over two consecutive readings. Total depth of well measurement should be made following sample collection, unless the datum is required to place nondedicated sample collection equipment. Depth to water and total well depth measurements should be made in accordance with procedures outlined in SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement).

If the well does not have a dedicated sample collection device, a new or previously decontaminated portable sample collection device should be placed within the well. The intake of the device should be positioned at the midpoint of the well screen interval. The device should be installed slowly to minimize turbulence within the water in the casing and mixing of stagnant water above the screened interval with water in the screened interval. Following installation, the flow controller should be connected to the sample collection device and the flow-through cell connected to the outlet of the sample collection device. The calibrated groundwater chemistry monitoring probes should be installed in the flow-through cell. If a flow meter is used, it should be installed ahead of the flow-through cell.

If the well has a dedicated sample collection device, the controller for the sample collection device should be connected to the sample collection device. The flow meter and flow-through cell should be connected in line to the discharge tube, and the probes installed in the flow-through cell.

The controller should be activated and groundwater extracted (purged) from the well. The purge rate should be monitored, and should not exceed the capacity of the well. The well capacity is defined as the maximum discharge rate that can be obtained with less than 0.1 meter (0.3 foot) drawdown. Typically, the discharge rate will be less than 0.5 liters per minute (L/min) (0.13 gallons per minute). The maximum purge rate should not exceed 1 L/min (0.25 gallons per minute), and should be adjusted to achieve minimal drawdown.

Water levels, effluent chemistry, and effluent flow rate should be continuously monitored while purging the well. Purging should continue until the measured chemical and optical parameters are stable. Stable parameters are defined as monitored chemistry values that do not fluctuate by more than the following ranges over three successive readings at 3-minute intervals: ±0.1 pH unit; ±3 percent for SC; ±10 mv for Eh; and ±10 percent for turbidity and DO. Purging will continue until these stabilization criteria have been met or three well casing volumes have been purged. If three casing volumes of water have been purged and the stabilization criteria have not been met, a comment should be made on the data sheet that sample collection began after three well casing volumes were purged. The final pH, SC, Eh, turbidity, and DO values will be recorded. All data should be recorded on the Micropurging Groundwater Sampling Data Sheet attached to this SOP or in a logbook.

2.3 SAMPLE COLLECTION

Following purging, the flow through cell shall be disconnected, and groundwater samples collected directly from the discharge line. Discharge rates should be adjusted so that groundwater is dispensed into the sample container with minimal aeration of the sample. Samples collected for volatile organic compound analysis should be dispensed into the sample container at a flow rate equal to or less than 100 milliliters per minute. Samples should be preserved and handled as described in the investigation field sampling plan or quality assurance project plan.

Tetra Tech EM Inc.

MICROPURGING GROUNDWATER SAMPLING DATA SHEET

Page _____ of _____

Date ____________

Well Name ____________________

Project ____________________

Project No. ____________________

Well Location ____________________

Sample Date ____________________

Sampling Personnel ____________________

____

____

Sample ID ____________________

Duplicate ID ____________________

Screen Interval ____________________

Station Elevation________ GND ____ TOC ______

Static Water Level (from TOC)____________

Well Stick Up ____________________

____

Well Depth __________ MEAS ____ RPTD ______

Feet of Water ____________________

Gallons/Foot ____________________

Casing Volume ____________________

Immiscible Phases Present ☐ Yes ☐ No

Type ____________________

Measured with ____________________

PID Readings (background)____________

PID Reading (TOC) ____________________

Wells Installed by ____________________

Installation Date ____________________

Development Date(s)____________________

FIELD CHEMISTRY CALIBRATIONS

Date/Time ____________________ Spec. Conductance: Standard________ µmhos/cm at 25EC Reading _________ µmhos/cm at _____EC

pH: pH 4.00 - _______ at _________EC pH 7.00 - _______ at _________EC pH 10.00 - ______ at _______EC Slope _______________

Dissolved Oxygen: D.O. Meter_______ mg/L at _______EC PID: Calibration Gas__________ PPM ______ Span ______ Reading ___________

PURGING

Time	Discharge Rate (mL/min)	Dissolved Oxygen (mg/L)	pH	Eh/ORP (mV)	Temp. (EC)	Specific Conduct. (µmhos/cm at EC)	Turbidity (NTU)	Cumulative Volume of Water Removed (Purged)		PID/OVA Reading		Depth to Water (ft)	Comments
								Gallons	Casing Vol.	Location	Value		

SAMPLE PARAMETERS

Condition of well: ____________________

Remarks: ____________________

FIELD EQUIPMENT

pH Meter ____________________ Serial Number ____________________

Spec. Cond. Meter ____________________ Serial Number ____________________

Pump ____________________ Serial Number ____________________

Water Level Meter ____________________ Serial Number ____________________

D.O. Meter ____________________ Serial Number ____________________

Filter Apparatus ____________________ Filters ____________________

Temperature Measure ____________________

Interface Probe ____________________ Serial Number ____________________

PID/OVA ____________________ Serial Number ____________________

Field Chemistry Calibrations

Fractions ____________________

____

____

Number of Bottles ____________________

Sample Depth ____________________

Field Notebook ____________________

Sample Method ____________________

____

Discharge Water Containerized ☐ Yes ☐ No

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

MONITORING WELL INSTALLATION

SOP NO. 020

REVISION NO. 3

Last Reviewed: December 2000

RRiesing

Quality Assurance Approved

December 19, 2000

Date

1.0 BACKGROUND

Groundwater monitoring wells are designed and installed for a variety of reasons including: (1) detecting the presence or absence of contaminants, (2) collecting groundwater samples representative of in situ aquifer chemical characteristics, or (3) measuring water levels for determining groundwater potentiometric head and groundwater flow direction.

Although detailed specifications for well installation may vary in response to site-specific conditions, some elements of well installation are common to most situations. This standard operating procedure (SOP) discusses common methods and minimum standards for monitoring well installation for Tetra Tech EM Inc. (Tetra Tech) projects. The SOP is based on widely recognized methods described by the U.S. Environmental Protection Agency (EPA) and American Society for Testing and Materials (ASTM). However, well type, well construction, and well installation methods will vary with drilling method, intended well use, subsurface characteristics, and other site-specific criteria. In addition, monitoring wells should be constructed and installed in a manner consistent with all local and state regulations. Detailed specifications for well installation should be identified within a site-specific work plan, sampling plan, or quality assurance project plan (QAPP).

General specifications and installation procedures for the following monitoring well components are included in this SOP:

- Monitoring well materials
  - Casing materials
  - Well screen materials
  - Filter pack materials
  - Annular sealant (bentonite pellets or chips)
  - Grouting materials
  - Tremie pipe
  - Surface completion and protective casing materials
  - Concrete surface pad and bumper posts
  - Uncontaminated water
- Monitoring well installation procedures
  - Well screen and riser placement
  - Filter pack placement
  - Temporary casing retrieval
  - Annular seal placement

  - Grouting
  - Surface completion and protective casing (aboveground and flush-mount)
  - Concrete surface pad and bumper posts
  - Permanent and multiple casing well installation

- Recordkeeping procedures
  - Surveying
  - Permits and well construction records
  - Monitoring well identification

Well installation methods will depend to some extent on the boring method. Specific boring or drilling protocols are detailed in other SOPs. The boring method, in turn, will depend on site-specific geology and hydrogeology and project requirements. Boring methods commonly used for well installation include:

- Hollow-stem augering
- Cable tool drilling
- Mud rotary drilling
- Air rotary drilling
- Rock coring

The hollow-stem auger method is preferred in areas where subsurface materials are unconsolidated or loosely consolidated and where the depth of the boring will be less than 100 feet. This maximum effective depth for hollow-stem augering depends on the diameter of the augers, the formation characteristics, and the strength and durability of the drilling equipment. This method is preferred because under the right conditions it is cost effective, addition of water into the subsurface is limited, continuous soil samples can easily be collected, and monitoring wells can easily be constructed within the hollow augers.

Cable tool drilling is a preferred method when the subsurface contains boulders, coarse gravels, or flowing sands, or when the operational depth of the hollow-stem auger is exceeded. However, this method is slow.

Rotary methods are generally used when other methods cannot be used. The use of drilling fluids or large amounts of water to maintain an open borehole, and the difficulty in obtaining representative samples limit the utility of rotary methods. However, rotary methods can be used to quickly and effectively drill deep wells through consolidated or unconsolidated materials. Modifications to this method such as dual-tube drilling procedures, drill-through casing hammers, or eccentric-type drill systems, can reduce the amount of fluids introduced into the well borehole.

Rock coring is an effective method when drilling in competent consolidated rock. Intact, continuous cores can be obtained, and limited amounts of fluid are required if the formations are not fractured.

1.1 PURPOSE

This SOP establishes the requirements and procedures for monitoring well installation. Monitoring wells should be designed to function properly throughout the duration of the monitoring program. The performance objectives for monitoring well installation are as follows:

- Ensure that the monitoring well will provide water samples representative of in situ aquifer conditions.
- Ensure that the monitoring well construction will last for duration of the project.
- Ensure that the monitoring well will not serve as a conduit for vertical migration of contaminants, particularly vertical migration between discrete aquifers.
- Ensure that the well diameter is adequate for all anticipated downhole monitoring and sampling equipment.

1.2 SCOPE

This SOP applies to the installation of monitoring wells. Although some of the procedures may apply to the installation of water supply wells, this SOP is not intended to cover the design and construction of such wells. The SOP identifies several well drilling methods related to monitoring well installation, but the scope of this SOP does not include drilling methods.

Other relevant SOPs include SOP 002 for decontamination of drilling and well installation equipment, SOP 005 for soil sampling, SOP 021 for monitoring well development, SOPs 010 and 015 for groundwater sampling from monitoring wells, and SOP 014 for measuring static water levels within monitoring wells.

1.3 DEFINITIONS

Annulus: The space between the monitoring well casing and the wall of the well boring.

Bentonite seal: A colloidal clay seal separating the sand pack from the annular grout seal.

Centralizer: A stainless-steel or plastic spacer that keeps the well screen and casing centered in the borehole.

Filter pack: A clean, uniform sand or gravel placed between the borehole wall and the well screen to prevent formation material from entering the screen.

Grout seal: A fluid mixture of (1) bentonite and water, (2) cement, bentonite, and water, or (3) cement and water placed above the bentonite seal between the casing and the borehole wall to secure the casing in place and keep water from entering the borehole.

Tremie pipe: A rigid pipe used to place the well filter pack, bentonite seal, or grout seal. The tremie pipe is lowered to the bottom of the well or area to be filled and pulled up ahead of the material being placed.

Well casing: A solid piece of pipe, typically polyvinyl chloride (PVC) or stainless steel, used to keep a well open in either unconsolidated material or unstable rock.

Well screen: A PVC or stainless steel pipe with openings of a uniform width, orientation, and spacing used to keep materials other than water from entering the well and to stabilize the surrounding formation.

1.4 REFERENCES

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1.5 REQUIREMENTS AND RESOURCES

Well installation requires a completed boring with stable or supported walls. The type of drilling rig needed to complete the boring and the well construction materials required for monitoring well installation will depend on the drilling method used, the geologic formations present, and chemicals of concern in groundwater. The rig and support equipment used to drill the borehole is usually used to install the well. Under most conditions, the following items are also required for the proper installation of monitoring wells:

- Tremie pipe and funnel
- Bentonite pellets or chips
- Grouting supplies
- Casing materials
- Well screen materials
- Filter pack materials

- Surface completion materials (protective casing, lockable and watertight well cover, padlock)
- Electronic water level sounding device for water level measurement
- Measuring tape with weight for measuring the depth of the well and determining the placement of filter pack materials
- Decontamination equipment and supplies
- Site-specific work plan, field sampling plan, health and safety plan, and QAPP
- Monitoring Well Completion Record (see Figure 1)

2.0 MONITORING WELL INSTALLATION PROCEDURES

This section presents standard procedures for monitoring well installation and is divided into three subsections. Section 2.1 addresses monitoring well construction materials, while Section 2.2 describes typical monitoring well installation procedures. Section 2.3 addresses recordkeeping requirements associated with monitoring well installation. Monitoring well installation procedures described in work plans, sampling plans, and QAPPs should be fully consistent with the procedures outlined in this SOP as well as any applicable local and state regulations and guidelines.

2.1 MONITORING WELL CONSTRUCTION MATERIALS

Monitoring well construction materials should be specified in the site-specific work plan as well as in the statement of work for any subcontractors assisting in the well installation. Well construction materials that come in contact with groundwater should not measurably alter the chemical quality of groundwater samples with regard to the constituents being examined. The riser, well screen, and filter pack and annular sealant placement equipment should be steam cleaned or high-pressure water cleaned immediately prior to well installation. Alternatively, these materials can be certified by the manufacturer as clean and delivered to the site in protective wrapping. Samples of the filter pack, annular seal, and mixed grout should be retained as a quality control measure until at least one round of groundwater sampling and analysis is completed.

This section discusses material specifications for the following well construction components: casing, well screen, filter pack, annular sealant (bentonite pellets or chips), grout, tremie pipes, surface completion components (protective casing, lockable and water tight cap, and padlock), concrete surface pad, and uncontaminated water. Figure 2 shows the construction details of a typical monitoring well.

2.1.1 Casing Materials

The material type and minimum wall thickness of the casing should be adequate to withstand the forces of installation. If the casing has not been certified as clean by the manufacturer or delivered to and maintained in clean condition at the site, the casing should be steam cleaned or high-pressure water cleaned with water from a source of known chemistry immediately prior to installation (see Tetra Tech SOP No. 002). The ends of each casing section should be either flush-threaded or beveled for welding.

Schedule 40 or Schedule 80 PVC casing is typically used for monitoring well installation. Either type of casing is appropriate for monitoring wells with depths less than 100 feet below ground surface (bgs). If the well is deeper than 100 feet bgs, Schedule 80 PVC should be used.

Stainless steel used for well casing is typically Type 304 and is of 11-gauge thickness.

2.1.2 Well Screen Materials

Well screens should be new, machine-slotted or continuous wrapped wire-wound, and composed of materials most suited for the monitoring environment based on site characterization findings. Well screens are generally constructed of the same materials used for well casing (PVC or stainless steel). The screen should be plugged at the bottom with the same material as the well screen. Alternatively, a short (1- to 2-foot) section of casing material with a bottom (sump) should be attached below the screen. This assembly must be able to withstand installation and development stresses without becoming dislodged or damaged. The length of the slotted area should reflect the interval to be monitored.

If the well screen has not been certified as clean by the manufacturer or delivered to and maintained in clean condition at the site, the screen should be steam cleaned or high-pressure water cleaned with water from a source of known chemistry immediately prior to installation (see Tetra Tech SOP No. 002).

The minimum internal diameter of the well screen should be chosen based on the particular application. A minimum diameter of 2 inches is usually needed to allow for the introduction and withdrawal of sampling devices. Typical monitoring well screen diameters are 2 inches and 4 inches.

The slot size of the well screen should be determined relative to (1) the grain size of particles in the aquifer to be monitored and (2) the gradation of the filter pack material.

Screen length and monitoring well diameter will depend on site-specific considerations such as intended well use, contaminants of concern, and hydrogeology. Some specific considerations include the following:

- Water table wells should have screens of sufficient length and diameter to monitor the water table and provide sufficient sample volume under high and low water table conditions.

- Wells with low recharge should have screens of sufficient length and diameter so that adequate sample volume can be collected.

- Wells should be screened over sufficiently short intervals to allow for monitoring of discrete migration pathways.

- Where light nonaqueous-phase liquids (LNAPL) or contaminants in the upper portion of a hydraulic unit are being monitored, the screen should be set so that the upper portion of the water-bearing zone is below the top of the screen.

- Where dense nonaqueous-phase liquids (DNAPL) are being monitored, the screen should be set within the lower portion of the water-bearing zone, just above a relatively impermeable lithologic unit.

- The screened interval should not extend across an aquiclude or aquitard.

- If contamination is known to be concentrated within a portion of a saturated zone, the screen should be constructed in a manner that minimizes the potential for cross-contamination within the aquifer.

- If downhole geophysical surveys are to be conducted, the casing and screen must be of sufficient diameter and constructed of the appropriate material to allow for effective use of the geophysical survey tools.

- If aquifer tests are to be conducted in a monitoring well, the slot size must allow sufficient flux to produce the required drawdown and recovery. The diameter of the well must be sufficient to house the pump and monitoring equipment, and allow sufficient water flux (in combination with the screen slot size) to produce the required drawdown or recovery.

2.1.3 Filter Pack Materials

The primary filter pack consists of a granular material of known chemistry and selected grain size and gradation. The filter pack is installed in the annulus between the well screen and the borehole wall. The grain size and gradation of the filter pack are selected to stabilize the hydrologic unit adjacent to the screen and to prevent formation material from entering the well during development. After development, a properly filtered monitoring well is relatively free of turbidity.

A secondary filter pack is a layer of material placed in the annulus directly above the primary filter pack and separates the filter pack from the annular sealant. The secondary filter pack should be uniformly graded fine sand, with 100 percent by weight passing through a No. 30 U.S. Standard sieve, and less than 2 percent by weight passing through a No. 200 U.S. Standard sieve.

2.1.4 Annular Sealant (Bentonite Pellets or Chips)

The materials used to seal the annulus may be prepared as a slurry or used as dry pellets, granules, or chips. Sealants should be compatible with ambient geologic, hydrogeologic, and climatic conditions and any man-induced conditions anticipated to occur during the life of the well.

Bentonite (sodium montmorillonite) is the most commonly used annular sealant and is furnished in sacks or buckets in powder, granular, pelletized, or chip form. Bentonite should be obtained from a commercial source and should be free of impurities that may adversely impact the water quality in the well. Pellets are compressed bentonite powder in roughly spherical or disk shapes. Chips are large, coarse, irregularly shaped units of bentonite. The diameter of the pellets or chips should be less than one-fifth the width of the annular space into which they will be placed in order to reduce the potential for bridging. Granules consist of coarse particles of unaltered bentonite, typically smaller than 0.2 inch in diameter. Bentonite slurry is prepared by mixing powdered or granular bentonite with water from a source of known chemistry.

2.1.5 Grouting Materials

The grout backfill that is placed above the bentonite annular seal is ordinarily liquid slurry consisting of either (1) a bentonite (powder, granules, or both) base and water, (2) a bentonite and Portland cement base and water, or (3) a Portland cement base and water. Often, bentonite-based grouts are used when flexibility is desired during the life of the well installation (for example, to accommodate freeze-thaw cycles). Cement- or bentonite-based grouts are often used when cracks in the surrounding geologic material must be filled or when adherence to rock units, or a rigid setting is desired.

Each type of grout mixture has slightly different characteristics that may be appropriate under various physical and chemical conditions. However, quick-setting cements containing additives are not recommended for use in monitoring well installation because additives may leach from the cement and influence the chemistry of water samples collected from the well.

2.1.6 Tremie Pipe

A tremie pipe is used to place the filter pack, annular sealant, and grouting materials into the borehole. The tremie pipe should be rigid, have a minimum internal diameter of 1.0 inch, and be made of PVC or steel. The length of the tremie pipe should be sufficient to extend to the full depth of the monitoring well.

2.1.7 Surface Completion and Protective Casing Materials

Protective casings that extend above the ground surface should be made of aluminum, steel, stainless steel, cast iron, or a structural plastic. The protective casing should have a lid with a locking device to prevent vandalism. Sufficient clearance, usually 6 inches, should be maintained between the top of the riser and the top of protective casing. A water-tight well cap should be placed on the top of the riser to seal the well from surface water infiltration in the event of a flood. A weep hole should be drilled in the casing a minimum of 6 inches above the ground surface to enable water to drain out of the annular space.

Flush-mounted monitoring wells (wells that do not extend above ground surface) require a water-tight protective cover of sufficient strength to withstand heavy traffic. The well riser should be fitted with a locking water-tight cap.

2.1.8 Concrete Surface Pad and Bumper Posts

A concrete surface pad should be installed around each well when the outer protective casing is installed. The surface pad should be formed around the well casing. Concrete should be placed into the formed pad and into the borehole (on top of the grout), typically to a depth of 1 to 3 feet bgs (depending on state, federal, and local regulations). The protective casing is then installed into the concrete. As a general guideline, if the well casing is 2 inches in diameter, the concrete pad should be 3 feet square and 4 inches thick. If the well casing is 4 inches in diameter, the pad should be 4 feet square and 6 inches thick. Round concrete pads are also acceptable.

The finished pad should be sloped so that drainage flows away from the protective casing and off the pad. The finished pad should extend at least 1 inch below grade. If the monitoring wells are located in high traffic areas, a minimum of three bumper posts should be installed around the pad to protect the well. Bumper posts, consisting of steel pipes 3 to 4 inches in diameter and at least 5 feet long, should be installed in a radial pattern around the protective casing, beyond the edges of the cement pad. The base of the bumper posts should be installed 2 feet bgs in a concrete footing; the top of the post should be capped or filled with concrete.

2.1.9 Uncontaminated Water

Water used in the drilling process, to prepare grout mixtures, and to decontaminate the well screen, riser, and annular sealant injection equipment, should be obtained from a source of known chemistry. The water should not contain constituents that could compromise the integrity of the monitoring well installation.

2.2 MONITORING WELL INSTALLATION PROCEDURES

This section describes the procedures used to install a single-cased monitoring well, with either temporary casing or hollow-stem augers to support the walls of the boring in unconsolidated formations. The procedures are described in the order in which they are conducted, and include: (1) placement of well screen and riser pipe, (2) placement of filter pack, (3) progressive retrieval of temporary casing, (4) placement of annular seal, (5) grouting, (6) surface completion and installation of protective casing, and (7) installation of concrete pad and bumper posts.

The additional steps necessary to install a well with permanent or multiple casing strings are described at the end of this section.

2.2.1 Well Screen and Riser Placement

After the total depth of the boring is confirmed and the well screen depth interval and the height of the aboveground completion are determined, the screen and riser is assembled from the bottom up as it is lowered down the hole. The following procedures should be followed:

1. Measure the total depth of the boring using a weighted tape.
2. Determine the length of screen and casing materials required to construct the well.
3. Assemble the well parts from the bottom up, starting with the well sump or cap, well screen, and then riser pipe. Progressively lower the assembled length of pipe.
4. The length of the assembled pipe should not extend above the top of the installation rig.

The well sump or cap, well screen, and riser should be certified clean by the manufacturer or should be decontaminated before assembly and installation. No grease, oil, or other contaminants should contact any portion of the assembly. Flush joints should be tightened, and welds should be water tight and of good quality. The riser should extend above grade and be capped temporarily to prevent entrance of foreign materials during the remaining well completion procedures.

When the well screen and riser assembly is lowered to the predetermined level, it may float and require a method to hold it in place. For borings drilled using cable tool or air rotary drilling methods, centralizers should be attached to the riser at intervals of between 20 and 40 feet.

2.2.2 Filter Pack Placement

The filter pack is placed after the well screen and riser assembly has been lowered into the borehole. The steps below should be followed:

1. Determine the volume of the annular space in the filter pack interval. The filter pack should extend from the bottom of the borehole to at least 2 feet above the top of the well screen.

2. Assemble the required material (sand pack and tremie pipe).

3. Lower a clean or decontaminated tremie pipe down the annulus to within 1 foot of the base of the hole.

4. Pour the sand down the tremie pipe using a funnel; pour only the quantity estimated to fill the first foot.

5. Check the depth of sand in the hole using a weighted tape.

6. Pull the drill casing up ahead of the sand to keep the sand from bridging.

7. Continue with this process (steps 4 through 6) until the filter pack is at the appropriate depth.

If bridging of the filter pack occurs, break out the bridge prior to adding additional filter pack material. For wells less than 30 feet deep installed inside hollow-stem augers, the sand may be poured in 1-foot lifts without a tremie pipe.

Sufficient measurements of the depth to the filter pack material and the depth of the bottom of the temporary casing should be made to ensure that the casing bottom is always above the filter pack. The filter pack should extend 2 feet above the well screen (or more if required by state or local regulations). However, the filter pack should not extend across separate hydrogeologic units. The final depth interval, volume, and type of filter pack should be recorded on the Monitoring Well Completion Record (Figure 1).

A secondary filter pack may be installed above the primary filter pack to prevent the intrusion of the bentonite grout seal into the primary filter pack. A measured volume of secondary filter material should be added to extend 1 to 2 feet above the primary filter pack. As with the primary filter pack, a secondary filter pack must not extend into an overlying hydrologic unit. An on-site geologist should evaluate the need for a secondary filter pack by considering the gradation of the primary filter pack, the hydraulic head difference between adjacent units, and the potential for grout intrusion into the primary filter pack.

The secondary filter material is poured into the annular space through tremie pipe as described above. Water from a source of known chemistry may be added to help place the filter pack into its proper location. The tremie pipe or a weighed line inserted through the tremie pipe can be used to measure the top of the secondary filter pack as work progresses. The amount and type of secondary filter pack used should be recorded on the Monitoring Well Completion Record (Figure 1).

2.2.3 Temporary Casing Retrieval

The temporary casing or hollow-stem auger should be withdrawn in increments. Care should be taken to minimize lifting the well screen and riser assembly during withdrawal of the temporary casing or auger. It may be necessary to place the top head of the rig on the riser to hold it down. To limit borehole collapse in formations consisting of unconsolidated materials, the temporary casing or hollow-stem auger is usually withdrawn until the lowest point of the casing or auger is at least 2 feet, but no more than 5 feet, above the filter pack. When the geologic formation consists of consolidated materials, the lowest point of the casing or auger should be at least 5 feet, but no more than 10 feet, above the filter pack. In highly unstable formations, withdrawal intervals may be much less. After each increment, the depth to the primary filter pack should be measured to check that the borehole has not collapsed or that bridging has not occurred.

2.2.4 Annular Seal Placement

A bentonite pellet, chip, or slurry seal should be placed between the borehole and the riser on top of the primary or secondary filter pack. This seal retards the movement of grout into the filter pack. The thickness of the bentonite seal will depend on state and local regulations, but the seal should generally be between 3 and 5 feet thick.

The bentonite seal should be installed using a tremie pipe, lowered to the top of the filter pack and slowly raised as the bentonite pellets or slurry fill the space. Care must be taken so that bentonite pellets or chips do not bridge in the augers or tremie pipe. The depth of the seal should be checked with a weighted tape or the tremie pipe.

If a bentonite pellet or chip seal is installed above the water level, water from a known source should be added to allow proper hydration of the bentonite. Sufficient time should be allowed for the bentonite seal to hydrate. The volume and thickness of the bentonite seal should be recorded on the Monitoring Well Completion Record (Figure 1).

2.2.5 Grouting

Grouting procedures vary with the type of well design. The volume of grout needed to backfill the remaining annular space should be calculated and recorded on the Monitoring Well Completion Record (Figure 1). The use of alternate grout materials, including grouts containing gravel, may be necessary to control zones of high grout loss. Bentonite grouts should not be used in arid regions because of their propensity to desiccate. Typical grout mixtures include the following:

- Bentonite grout: about 1 to 1.25 pounds of bentonite mixed with 1 gallon of water
- Cement-bentonite grout: about 5 pounds of bentonite and one 94-pound bag of cement mixed with 7 to 8 gallons of water
- Cement grout: one 94-pound bag of cement mixed with 6 to 7 gallons of water

The grout should be installed by gravity feed through a tremie pipe. The grout should be mixed in batches in accordance with the appropriate requirements and then pumped into the annular space until full-strength grout flows out at the ground surface without evidence of drill cuttings or fluid. The tremie pipe should then be removed to allow the grout to cure.

The riser should not be disturbed until the grout sets and cures for the amount of time necessary to prevent a break in the seal between the grout and riser. For bentonite grouts, curing times are typically around 24 hours; curing times for cement grouts are typically 48 to 72 hours. However, the curing time required will vary with grout content and climatic conditions. The curing time should be documented in the Monitoring Well Completion Record (Figure 1).

2.2.6 Surface Completion and Protective Casing

Aboveground completion of the monitoring well should begin once the grout has set (no sooner than 24 hours after the grout was placed). The protective casing is lowered over the riser and set into the cured grout. The protective casing should extend below the ground surface to a depth below the frost line (typically 3 to 5 feet, depending on local conditions). The protective casing is then cemented in place. A minimum of 6 inches of clearance should be maintained between the top of the riser and the protective casing. A 0.5-inch diameter drainage or weep hole should be drilled in the protective casing approximately 6 inches above the ground surface to enable water to drain out of the annular space between the casing and riser. A water-tight cap should be placed on top of the riser to seal the well from surface water infiltration in the event of a flood. A lock should be placed on the protective casing to prevent vandalism.

For flush-mounted monitoring wells, the well cover should be raised above grade and the surrounding concrete pad sloped so that water drains away from the cover. The flush-mount completion should be installed in accordance with applicable state and local regulations.

2.2.7 Concrete Surface Pad and Bumper Posts

The concrete pad installed around the monitoring well should be sloped so that the drainage will flow away from the protective casing and off the pad. The finished pad should extend at least 1 inch below grade. If the monitoring wells are located in high traffic areas, a minimum of three bumper posts should be installed in a radial pattern around the protective casing, outside the cement pad. Specifications for concrete surface pads and bumper posts are described in Section 2.1.8.

2.2.8 Permanent and Multiple Casing Well Installation

When wells are installed through multiple saturated zones, special well construction methods should be used to assure well integrity and limit the potential for cross-contamination between geologic zones. Generally, these types of wells are necessary if relatively impermeable layers separate hydraulic units. Two procedures that may be used are described below.

In the first procedure, the borehole is advanced to the base of the first saturated zone. Casing is then anchored in the underlying impermeable layer (aquitard) by advancing the casing at least 1 foot into the aquitard and grouting to the surface. After the grout has cured, a smaller diameter borehole is drilled through the grout. This procedure is repeated until the zone of interest is reached. After the zone is reached, a conventional well screen and riser are set. A typical well constructed in this manner is shown on Figure 3.

A second acceptable procedure involves driving a casing through several saturated layers while drilling ahead of the casing. However, this method is not acceptable when the driven casing may structurally damage a competent aquitard or aquiclude and result in cross-contamination of the two saturated layers. This method should also be avoided when highly contaminated groundwater or nonaqueous-phase contamination may be dragged down into underlying uncontaminated hydrologic units.

2.3 RECORDKEEPING PROCEDURES

Recordkeeping procedures associated with monitoring well installation are described in the following sections. These include procedures for surveying, obtaining permits, completing well construction records, and identifying monitoring wells.

2.3.1 Surveying

Latitude, longitude, and elevation at the top of the riser should be determined for each monitoring well. A permanent notch or black mark should be made on the north side of the riser. The top of the riser and ground surface should be surveyed.

2.3.2 Permits and Well Construction Records

Local and state regulations should be reviewed prior to monitoring well installation, and any required well permits should be in-hand before the driller is scheduled.

Monitoring well installation activities should be documented in both the field logbook and on the Monitoring Well Completion Record (Figure 1). Geologic logs should be completed and, if necessary, filed with the appropriate regulatory agency within the appropriate time frame.

2.3.3 Monitoring Well Identification

Each monitoring well should have an individual well identification number or name. The well identification may be stamped in the metal surface upon completion or permanently marked by using another method. Current state and local regulations should be checked for identification requirements (such as township, range, section, or other identifiers in the well name).

FIGURE 1

MONITORING WELL COMPLETION RECORD

TETRATECH EM INC

MONITORING WELL COMPLETION RECORD

MONITORING WELL

MONITORING WELL NO.: ____________
PROJECT: ____________
SITE: ____________
BOREHOLE NO.: ____________
WELL PERMIT NO.: ____________
TOC TO BOTTOM OF WELL: ____________

DRILLING INFORMATION

DRILLING BEGAN:
DATE: ________ TIME: ________
WELL INSTALLATION BEGAN:
DATE: ________ TIME: ________
WELL INSTALLATION FINISHED:
DATE: ________ TIME: ________
DRILLING CO.: ____________
DRILLER: ____________
LICENSE: ____________
DRILL RIG: ____________
DRILLING METHOD:
- ❑ HOLLOW-STEM AUGER
- ❑ AIR ROTARY
- ❑ OTHER: ____________

DIAMETER OF AUGERS:
ID: ________ OD: ________

WELL CASING

- ❑ SCHEDULE 40 PVC
- ❑ OTHER: ____________

PRODUCT: ____________
MFG. BY: ____________
CASING DIAMETER:
ID: ________ OD: ________
LENGTH OF CASING: ____________

WELL SCREEN

- ❑ SCHEDULE 40 PVC
- ❑ OTHER: ____________

PRODUCT: ____________
MFG. BY: ____________
CASING DIAMETER:
ID: ________ OD: ________
SLOT SIZE: ____________
LENGTH OF SCREEN: ____________

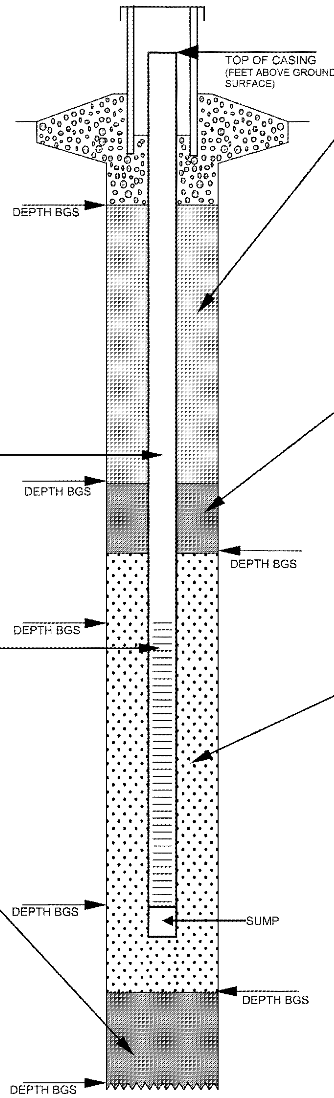
BOREHOLE BACKFILL

AMOUNT CALCULATED: ____________
AMOUNT USED: ____________
- ❑ BENTONITE CHIPS, SIZE: ____________
- ❑ BENTONITE PELLETS, SIZE: ____________
- ❑ SLURRY: ____________
- ❑ FORMATION COLLAPSE: ____________
- ❑ OTHER: ____________

PRODUCT: ____________
MFG. BY: ____________
METHOD INSTALLED:
- ❑ POURED ❑ TREMIE
- ❑ OTHER: ____________

SURFACE COMPLETION

- ❑ FLUSH MOUNT
- ❑ ABOVE GROUND WITH BUMPER POST
- ❑ CONCRETE ❑ ASPHALT



SURVEY INFORMATION

TOC ELEVATION: ____________
GROUND SURFACE ELEVATION: ____________
NORTHING: ____________
EASTING: ____________
DATE SURVEYED: ____________
SURVEY CO.: ____________

ANNULAR SEAL

VOLUME CALCULATED: ____________
AMOUNT USED: ____________
- ❑ GROUT FORMULA (PERCENTAGES)
  - PORTLAND CEMENT: ____________
  - BENTONITE: ____________
  - WATER: ____________
- ❑ PREPARED MIX
  - PRODUCT: ____________
  - MFG. BY: ____________

METHOD INSTALLED:
- ❑ POURED ❑ TREMIE
- ❑ OTHER: ____________

BENTONITE SEAL

VOLUME CALCULATED: ____________
AMOUNT USED: ____________
- ❑ PELLETS, SIZE: ____________
- ❑ CHIPS, SIZE: ____________
- ❑ OTHER: ____________

PRODUCT: ____________
MFG. BY: ____________
METHOD INSTALLED:
- ❑ POURED ❑ TREMIE
- ❑ OTHER: ____________

AMOUNT OF WATER USED: ____________

FILTER PACK

- ❑ PREPACKED FILTER

VOLUME CALCULATED: ____________
AMOUNT USED: ____________
- ❑ SAND, SIZE: ____________

PRODUCT: ____________
MFG. BY: ____________
METHOD INSTALLED:
- ❑ POURED ❑ TREMIE
- ❑ OTHER: ____________

WATER LEVEL: ______
(BTOC AFTER WELL INSTALLATION)

CENTRALIZERS USED?

❑ YES ❑ NO;
CENTRALIZER DEPTHS: ______ ______

LEGEND

BGS = BELOW GROUND SURFACE
BTOC = BELOW TOP OF CASING
N/A = NOT APPLICABLE
NR = NOT RECORDED
TOC = TOP OF CASING
ID = INSIDE DIAMETER
OD = OUTSIDE DIAMETER

FIGURE 2

MONITORING WELL CONSTRUCTION DIAGRAM

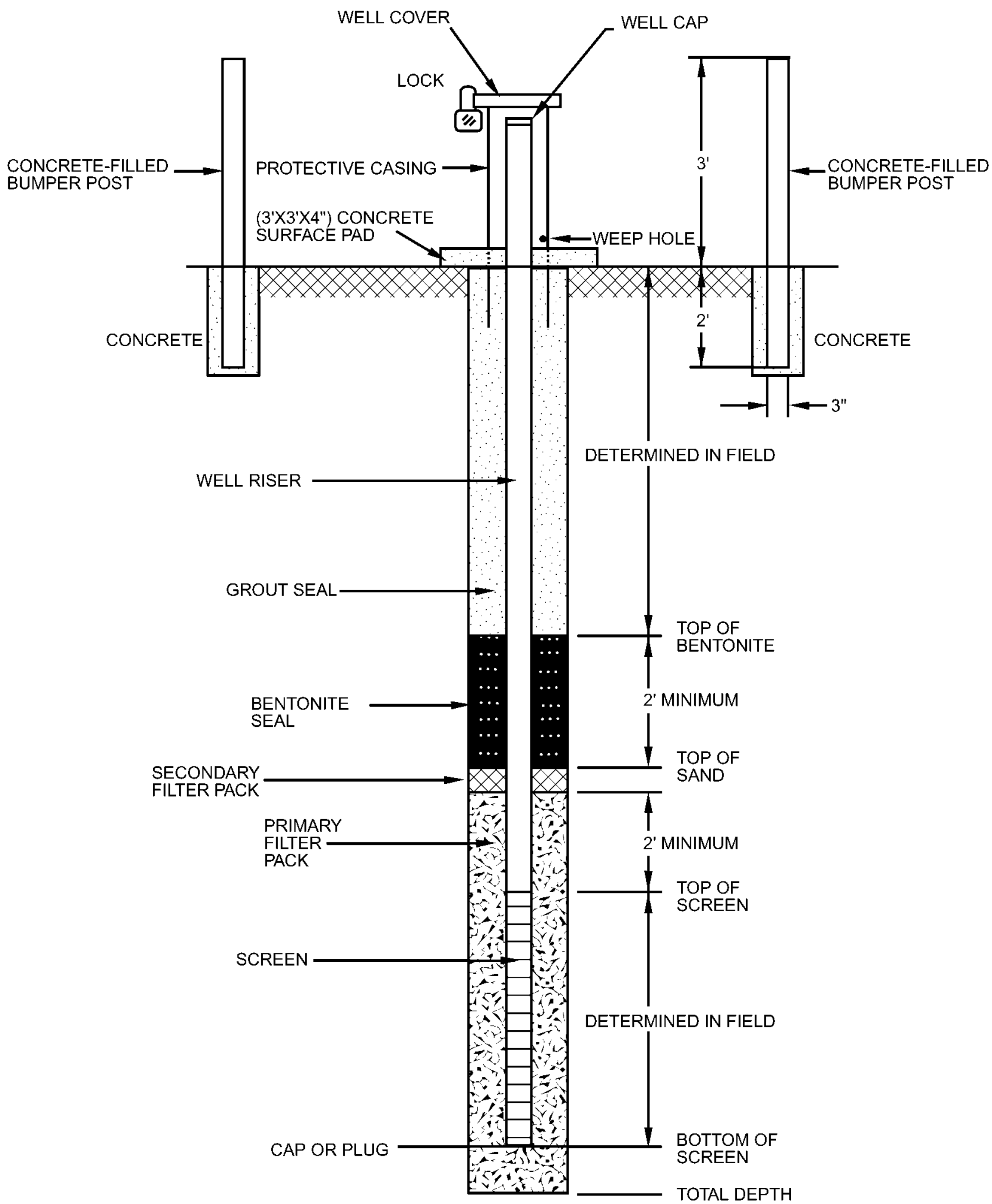
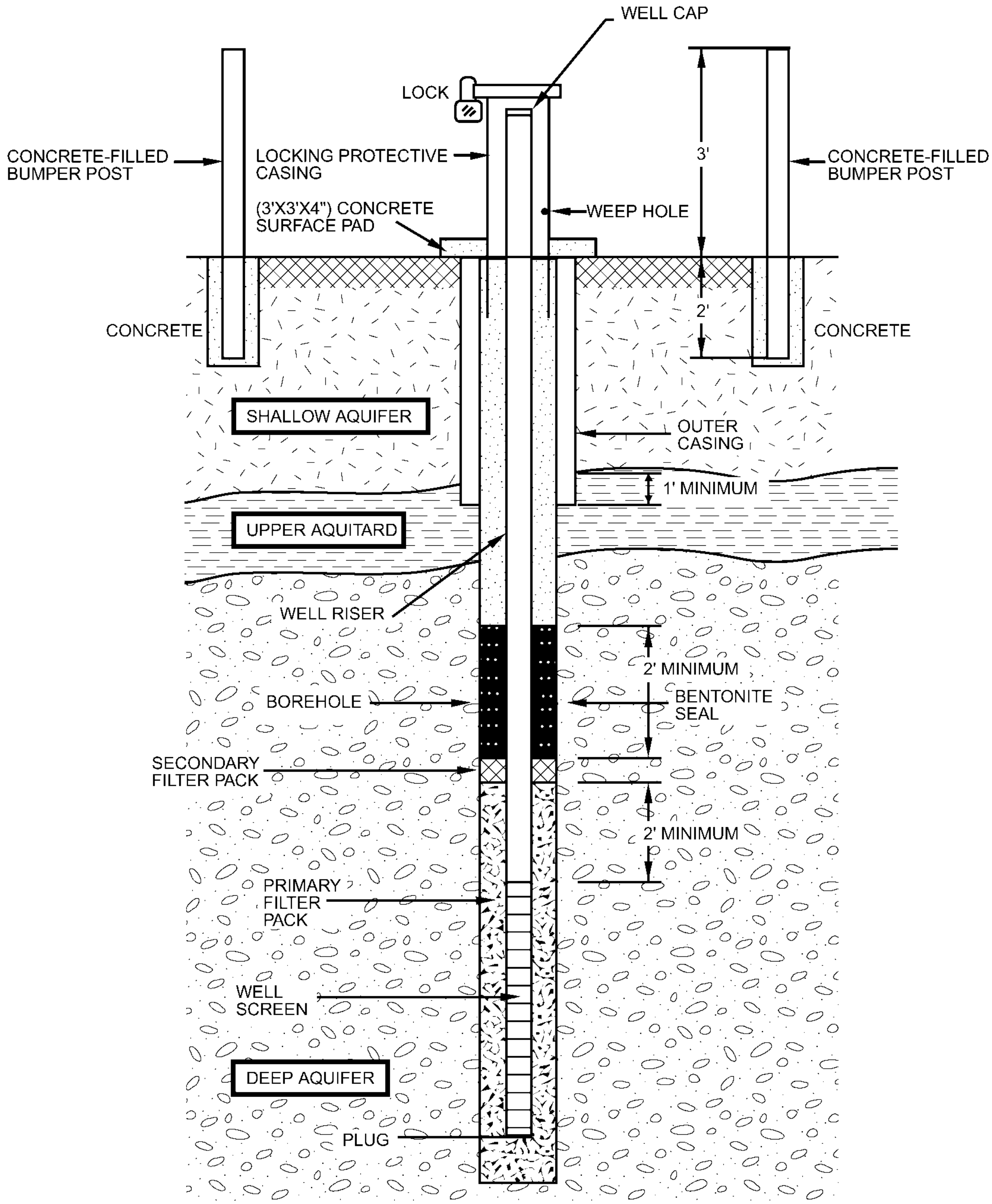


FIGURE 3

MULTIPLE CASING WELL CONSTRUCTION DIAGRAM



SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

MONITORING WELL DEVELOPMENT

SOP NO. 021

REVISION NO. 3

Last Reviewed: October 2000

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Quality Assurance Approved | Date

1.0 BACKGROUND

All drilling methods impair the ability of an aquifer to transmit water to a drilled hole. This impairment is typically a result of disturbance of soil grains (smearing) or the invasion of drilling fluids or solids into the aquifer during the drilling process. The impact to the hydrologic unit surrounding the borehole must be remediated so that the well hydraulics and samples collected from the monitoring well are representative of the aquifer.

Well development should be conducted as an integral step of monitoring well installation to remove the finer-grained material, typically clay and silt, from the geologic formation near the well screen and filter pack. (Monitoring well installation is discussed in standard operating procedure [SOP] No. 020.) The fine-grained particles may interfere with water quality analyses and alter the hydraulic characteristics of the filter pack and the hydraulic unit adjacent to the well screen. Well development improves the hydraulic connection between water in the well and water in the formation. The most common well development methods are surging, jetting, overpumping, and bailing.

The health and safety plan for the site should be followed to avoid exposure to chemicals of concern. Water, sediment, and other waste removed from a monitoring well should be disposed of in accordance with applicable federal, state, and local requirements.

1.1 PURPOSE

This SOP establishes the requirements and procedure for monitoring well development. Well development improves the hydraulic characteristics of the filter pack and borehole wall by performing the following functions:

- Reducing the compaction and the intermixing of grain sizes produced during drilling by removing fine material from the pore spaces.
- Removing the filter cake or drilling fluid film that coats the borehole as well as much or all of the drilling fluid and natural formation solids that have invaded the formation.
- Creating a graded zone of sediment around the screen, thereby stabilizing the formation so that the well can yield sediment-free water.

1.2 SCOPE

This SOP applies to the development of newly installed monitoring wells. The SOP identifies the most commonly used well development methods; these methods can be used individually or in combination to achieve the most effective well development. Selection of a particular method will depend on site conditions, equipment limitations, and other factors. The method selected and the rationale for selection should be documented in a field logbook or appropriate project reports.

1.3 DEFINITIONS

Aquifer: A geologic formation, group of formations, or part of a formation that is saturated and capable of storing and transmitting water.

Aquitard: a geologic formation, group of formations, or part of a formation through which virtually no water moves.

Bailer: A cylindrical sampling device with valves on either end, used to extract water from a well or borehole.

Bentonite seal: A colloidal (extremely fine particle that will not settle out of solution) clay seal separating the sand pack from the surface seal.

Drilling fluid: A fluid (liquid or gas) that may be used in drilling operations to remove cuttings from the borehole, to clean and cool the drill bit, and to maintain the integrity of the borehole during drilling.

Filter pack: A clean, uniform sand or gravel placed between the borehole wall and the well screen to prevent formation material from entering the screen.

Grout seal: A fluid mixture of (1) cement and water or (2) cement, bentonite, and water that is placed above the bentonite seal between the casing and the borehole wall to secure the casing in place and keep water from entering the borehole.

Hydraulic conductivity: A measure of the ease with which water moves through a geologic formation. Hydraulic conductivity, K, is typically measured in units of distance per time in the direction of groundwater flow.

Hydrologic units: Geologic strata that can be distinguished on the basis of capacity to yield and transmit fluids. Aquifers and confining units are types of hydrologic units.

Oil air filter: A filter or series of filters placed in the airflow line from an air compressor to reduce the oil content of the air.

Oil trap: A device used to remove oil from the compressed air discharged from an air compressor.

Riser: The pipe extending from the well screen to or above the ground surface.

Specific conductance: A measure of the ability of the water to conduct an electric current. Specific conductance is related to the total concentration of ionizable solids in the water and is inversely proportional to electrical resistance.

Static water level: The elevation of the top of a column of water in a monitoring well or piezometer that is not influenced by pumping or conditions related to well installation, hydrologic testing, or nearby pumpage.

Transmissivity: The volume of water transmitted per unit width of an aquifer over the entire thickness of the aquifer flow, under a unit hydraulic gradient.

Well screen: A cylindrical pipe with openings of a uniform width, orientation, and spacing used to keep materials other than water from entering the well and to stabilize the surrounding formation.

Well screen jetting (hydraulic jetting): A jetting method used for development; nozzles and a high pressure pump are used to force water outwardly through the screen, the filter pack, and sometimes into the adjacent geologic unit.

1.4 REFERENCES

American Society for Testing and Materials. 1990. Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers. D5092-90. West Conshohocken, Pennsylvania.

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1.5 REQUIREMENTS AND RESOURCES

The type of equipment used for well development will depend on the well development method. Well development methods and the equipment required are discussed in Section 2.1 of this SOP. In general, monitoring wells should be developed shortly after they are installed but no sooner than 24 hours after the placement of the grout seal, depending on the grout cure rate and well development method. Most drilling or well development rigs have pumps, air compressors, bailers, surge blocks, and other equipment that can be used to develop a monitoring well.

All downhole equipment should be properly decontaminated before and after each well is developed. See SOP No. 002 (General Equipment Decontamination) for details.

2.0 WELL DEVELOPMENT PROCEDURES

This section describes common well development methods, factors to be considered in selecting a well development method, procedures for initiating well development, well development duration, and calculations typically made during well development. In addition to this, procedures described in any work plans for well development should be fully consistent with local and state regulations and guidelines.

2.1 WELL DEVELOPMENT METHODS

Well development methods vary with the physical characterization of hydrologic units in which the monitoring well is screened and the drilling method used. The most common methods include mechanical surging, overpumping, air lift pumping, backwashing, surge bailing, and well jetting. These methods may be effective alone or may need to be combined (for example, overpumping combined with backwashing). Factors such as well design and hydrogeologic conditions will determine which well development method will be most practical and cost-effective. Commonly used well development methods are described in Sections 2.1.1 through 2.1.6.

The use of chemicals for monitoring well development should be avoided as much as possible. Introduction of chemicals may significantly alter groundwater chemistry in and around the well.

2.1.1 Mechanical Surging

The mechanical surging method forces water to flow in and out of the well screen by operating a plunger (or surge block) in the casing, similar to a piston in a cylinder. A typical surge block is shown in Figure 1. The surge block should fit snugly in the well casing to increase the surging action. The surge block is attached to a drill rod or drill stem and is of sufficient weight to cause the block to drop rapidly on the down stroke, forcing water contained in the borehole into the aquifer surrounding the well. In the recovery stroke or upstroke, water is lifted by the surge block, allowing water and fine sediments to flow back into the well from the aquifer. Down strokes and recovery strokes are usually 3 to 5 feet in length.

The surge block should be lowered into the water column above the well screen. The water column will effectively transmit the action of the block to the filter pack and hydrologic unit adjacent to the well screen. Development should begin above the screen and move progressively downward to prevent the surge block from becoming sand locked in the well. The initial surging action should be relatively gentle, allowing any material blocking the screen to break up, go into suspension, and then move into the well. As water begins to move easily both in and out of the screen, the surge block is usually lowered in increments to a level just above the screen. As the block is lowered, the force of the surging movement should be increased. In wells equipped with long screens, it may be more effective to operate the surge block in the screen to concentrate its actions at various levels.

A pump or bailer should be used periodically to remove dislodged sediment that may have accumulated at the bottom of the well during the surging process. The pump or bailer should be moved up and down at the bottom of the well to suspend and collect as much sediment as possible.

The accumulation of material developed from a specific screen interval can be measured by sounding the total depth of the well before and after surging. Continue surging until little or no sand accumulates.

2.1.2 Overpumping

Overpumping involves pumping the well at a rate substantially higher than it will be pumped during well purging and groundwater sampling. This method is most effective on coarse-grained formations and is usually conducted in conjunction with mechanical surging or backwashing. Overpumping is commonly implemented using a submersible pump. In cases were the water table is less than 30 feet from the top of the casing, it is possible to overpump the well with a centrifugal pump. The intake pipe is lowered into the water column at a depth sufficient to ensure that the water in the well is not drawn down to the pump intake level. The inflow of water at the well screen is not dependent on the location of the pump intake as long as it remains submerged.

Overpumping will induce a high velocity water flow, resulting in the flow of sand, silt, and clay into the well, opening clogged screen slots and cleaning formation voids and fractures. The movement of these particles at high flow rates should eliminate particle movement at the lower flow rates used during well purging and sampling. The bridging of particles against the screen because of the flow rate and direction created by overpumping may be overcome by using mechanical surging or backwashing in conjunction with this method.

2.1.3 Air Lift Pumping

Air lift pumping uses a two-pipe system consisting of an air injection pipe and a discharge pipe. In this well development method, an air lift pump is operated by cycling the air pressure on and off for short periods of time. This operation provides a surging action that can dislodge fine-grained particles in the vicinity of the well screen. Subsequently applying a steady low pressure removes the fines drawn into the well by the surging action.

The bottom of the air lift should be at least 10 feet above the top of the well screen. Air is injected through an inner pipe at sufficient pressure to bubble out directly into the surrounding discharge pipe. The bubbles formed by the injected air cause the column of water in the discharge pipe to be lifted upward and allow water from the aquifer to flow into the well. This arrangement prevents injected air from entering the well screen. Pumping air through the well screen and into the filter pack and adjacent hydrologic unit should be avoided because it can cause air entrainment, inhibiting future sampling efforts and possibly altering groundwater chemistry.

The air injected into the well should be filtered using an oil/air filter and oil trap to remove any compressor lubricant entrained in the air. Air pressures required for this well development method are relatively low; an air pressure of 14.8 pounds per square inch should move a 30-foot column of water. For small-diameter, shallow wells where the amount of development water is likely to be limited, tanks of inert gas (such as nitrogen) can be used as an alternative to compressed air.

2.1.4 Backwashing

Effective development procedures should cause flow reversals through the screen openings that will agitate the sediment, remove the finer fraction, and then rearrange the remaining formation particles. Backwashing overcomes the bridging that results from overpumping by allowing the water that is pumped to the top of the well to flow back through the submersible pump and out through the well screen. The backflow portion of the backwashing cycle breaks down bridging, and the inflow then moves the fine material toward the screen and into the well.

Some wells respond satisfactorily to backwashing techniques, but the surging effect is not vigorous enough to obtain maximum results in many cases.

A variation of backwashing may be effective in low-permeability formations. After the filter pack is installed on a monitoring well, clean water is circulated down the well casing, out through the well screen and filter pack, and up through the open borehole before the grout or bentonite seal is placed in the annulus. Flow rates should be controlled to prevent floating the filter pack. Because of the low hydraulic conductivity of the formation, negligible amounts of water will infiltrate into the formation. Immediately after this procedure, the bentonite seal should be installed, and the nonformation water should be pumped out of the well and filter pack.

2.1.5 Surge Bailing

Surge bailing can be an effective well development method in relatively clean, permeable formations where water flows freely into the borehole. A bailer made of stainless steel or polyvinyl chloride and slightly smaller than the well casing diameter is allowed to fall freely through the borehole until it strikes the groundwater surface. The contact of the bailer produces a downward force and causes water to flow outward through the well screen, breaking up bridging that has developed around the screen. As the bailer fills and is rapidly withdrawn from the well, the drawdown created causes fine particles to flow through the well screen and into the well. Subsequent bailing can remove these particles from the well. Lowering the bailer to the bottom of the well and using rapid short strokes to agitate and suspend solids that have settled to the well bottom can enhance removal of sand and fine particles. Bailing should continue until the water is free of suspended particles.

2.1.6 Well Jetting

Well jetting can be used to develop monitoring wells in both unconsolidated and consolidated formations. Water jetting can open fractures and remove drilling mud that has penetrated the aquifer. The discharge force of the jetting tool is concentrated over a small area of the well screen. As a result, the tool must be rotated constantly while it is raised and lowered in a very small increments to be sure that all portions of the screen are exposed to the jetting action.

Jetting is relatively ineffective on the fine screens typically used in monitoring wells (slot sizes from 0.01 to 0.02 inch). In addition, jetting requires the introduction of external water into the well and surrounding formation. This water should be obtained from a source of known chemistry. Water introduced for development should be completely removed from the aquifer immediately after development.

The use of compressed air as a jetting agent should not be employed for development of monitoring wells. Compressed air could entrain air in the formation, introduce oil into the formation, and damage the well screen.

2.2 FACTORS TO CONSIDER WHEN SELECTING A WELL DEVELOPMENT METHOD

It is important to check federal, state, and local regulatory requirements for monitoring well development requirements. This SOP may be changed to accommodate applicable regulations, site conditions, or equipment limitations.

The type of geologic material, the design and completion of the well, and the type of drilling method used are all factors to be considered during the development of a monitoring well.

Monitoring well development should usually be started slowly and gently and then performed with increasing vigor as the well is developed. Most well development methods require the application of sufficient energy to disturb the filter pack, thereby freeing fine particles and allowing them to be drawn into the well. The coarser particles then settle around and stabilize the screen.

Development procedures for wells completed in fine sand and silt strata should involve methods that are relatively gentle so that strata material will not be incorporated into the filter pack. Vigorous surging for development can produce mixing of the fine strata and filter pack and produce turbid samples from the formation. In addition, development methods should be carefully selected based upon the potential contaminants present, the quantity of wastewater generated, and requirements for containerization or treatment of wastewater.

For small diameter and small volume wells, a development bailer can be used in place of a submersible pump in the pumping method. Similarly, a bailer can be used in much the same fashion as a surge block in small diameter wells.

Any time an air compressor is used for well development, it should be equipped with an oil air filter or oil trap to minimize the introduction of oil into the screened area. The presence of oil could impact the organic constituent concentrations of the water samples collected from the well.

The presence of light nonaqueous phase liquid (LNAPL) can impact monitoring well development. Water jetting or vacuum-enhanced well development may assist in breaking down the smear zone in the LNAPL. Normal development procedures are conducted in the water-saturated zone and do not affect the LNAPL zone.

2.3 INITIATING WELL DEVELOPMENT

Newly completed monitoring wells should be developed as soon as practical, but no sooner than 24 hours after grouting is completed if rigorous well development methods are used. Development may be initiated shortly after well installation if the development method does not interfere with the grout seal. State and local regulations should be checked for guidance. The following general well development steps can be used with any of the methods described in Section 2.1.

1. Assemble the necessary equipment on a plastic sheet around the well. This may include a water level meter (or oil/water interface probe if LNAPL or dense nonaqueous phase liquid is present); personal protective equipment; pH, conductivity, temperature, and turbidity meters; air monitoring equipment; Well Development Data Sheets (see Figure 2); a watch; and a field logbook.

2. Open the well and take air monitoring readings at the top of the well casing and in the breathing zone. See SOP No. 003 (Organic Vapor Air Monitoring) for additional guidance.

3. Measure the depth to water and the total depth of the monitoring well. See SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement) for additional guidance.

4. Measure the initial pH, temperature, turbidity, and specific conductance of the groundwater from the first groundwater that comes out of the well. Note the time, initial

color, clarity, and odor of the water. Record the results on a Well Development Data Sheet (see Figure 2) or in a field logbook. See SOPs No. 011 (Field Measurement of Water Temperature), 012 (Field Measurement of pH), 013 (Field Measurement of Specific Conductance), and 088 (Field Measurement of Water Turbidity) for additional guidance.

5. Develop the well using one or more of the methods described in Section 2.1 until the well is free of sediments and the groundwater turbidity has reached acceptable levels. Record the development method and other pertinent information on a Well Development Data Sheet see Figure 2) or in a field logbook.

6. Containerize any groundwater produced during well development if groundwater contamination is suspected. The containerized water should be sampled and analyzed to determine an appropriate disposal method.

7. Do not add water to assist in well development unless the water is from a source of known chemical quality and the addition has been approved by the project manager. If water is added, five times the amount of water introduced should be removed during development.

8. Continue to develop the well, repeating the water quality measurements for each borehole volume. Development should continue until each water quality parameter is stable to within 10 percent. Development should also continue until all the water added during development (if any) is removed or the water has a turbidity of less than 50 nephelometric turbidity units. This level may only be attainable after allowing the well to settle and testing at low flow sampling rates.

9. At the completion of well development, measure the final pH, temperature, turbidity, and specific conductance of the groundwater. Note the color, clarity, and odor of the water. Record the results on a Well Development Data Sheet (see Figure 2) or in a field logbook. In addition to the final water quality parameters, the following data should be noted on the Well Development Data Sheet: well identification, date(s) of well installation, date(s) and time of well development, static water level before and after development, quantity of water removed and time of removal, type and capacity of pump or bailer used, and well development technique.

All contaminated water produced during development should be containerized in drums or storage vessels properly labeled with the date collected, generating address, well identification, and consultant contact number.

2.4 DURATION OF WELL DEVELOPMENT

Well development should continue until representative water, free of the drilling fluids, cuttings, or other materials introduced during well construction is obtained. When pH, temperature, turbidity, and specific conductance readings stabilize and the water is visually clear of suspended solids, the water is representative of formation water. The minimum duration of well development should vary in accordance with the method used to develop the well. For example, surging and pumping the well may provide a stable, sediment free sample in a matter of minutes, whereas bailing the well may require several hours of continuous effort to obtain a clear sample.

An on-site project geologist should make the final decision as to whether well development is complete. This decision should be documented on a Well Development Data Sheet (see Figure 2) or in a field logbook.

2.5 CALCULATIONS

It is necessary to calculate the volume of water in the well. Monitoring well diameters are typically 2, 3, 4, or 6 inches. The height of water column (in feet) in the well can be multiplied by the following conversion factors to calculate the volume of water in the well casing.

Well Diameter (inches)	Volume (gallon per foot)
2	0.1631
3	0.3670
4	0.6524
6	1.4680

3.0 POTENTIAL PROBLEMS

The following potential problems can occur during development of monitoring wells:

- In some wells the pH, temperature, and specific conductance may stabilize but the water remains turbid. When this occurs, the well may still contain construction materials (such as drilling mud in the form of a mud cake) and formation soils that have not been washed out of the borehole. Excessive or thick drilling muds cannot be flushed out of a borehole with one or two well volumes of flushing. Continuous flushing over a period of several days may be necessary to complete well development. If the well is completed in a silty zone, it may be necessary to sample with low flow methods or filtering.

- Mechanical surging and well jetting disturb the formation and filter pack more than other well development methods. In formations with high clay and silt contents, surging and jetting can cause the well screen to become clogged with fines. If an excessive amount of fines is produced, sand locking of the surge block may result. Well development with these methods should be initiated gently to minimize disturbance of the filter pack and to prevent damage to the well screen.

- Effective overpumping may involve the discharge of large amounts of groundwater. This method is not recommended when groundwater extracted during well development is contaminated with hazardous constituents. If the hazardous constituents are organic compounds, this problem can be partially overcome by passing the groundwater through an activated carbon filter.

- When a well is developed by mechanical surging or bailing, rapid withdrawal of the surge block or bailer can result in a large external pressure outside of the well. If the withdrawal is too rapid and this pressure is too great, the well casing or screen can collapse.

- A major disadvantage of well jetting is that an external supply of water is needed. The water added during well jetting may alter the hydrochemistry of the aquifer; therefore, the water added in this development procedure should be obtained from a source of known chemistry. In addition, the amount of water added during well development and the amount lost to the formation should be recorded.

- The use of air in well development can chemically alter the groundwater, either directly through chemical reaction or indirectly as a result of impurities introduced through the air stream. In addition, air entrainment within the formation can interfere with the flow of groundwater into the monitoring well. Consequently, air should not be injected in the immediate vicinity of the well screen.

FIGURE 1

SCHEMATIC DRAWING OF A SURGE BLOCK

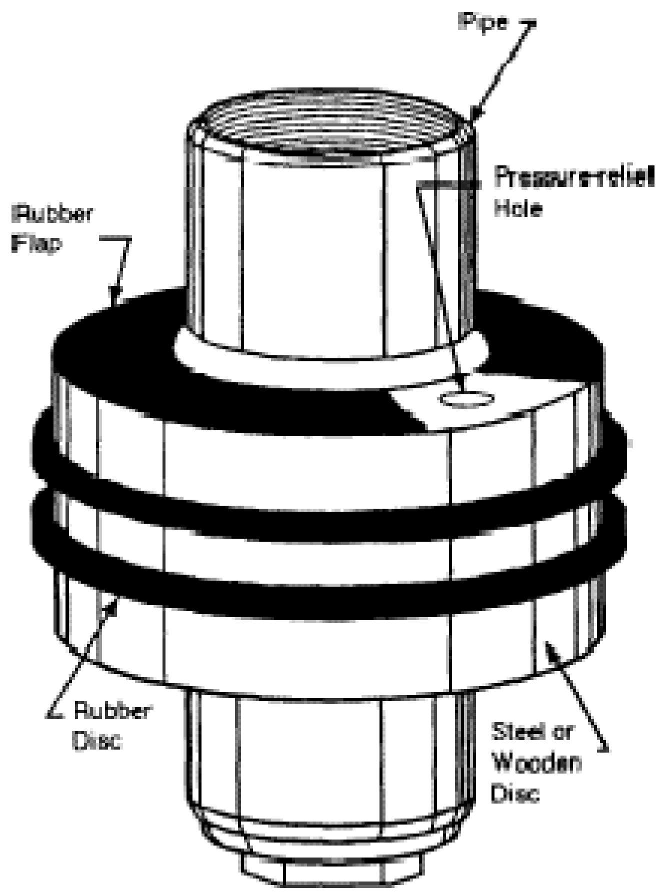

FIGURE 2

WELL DEVELOPMENT DATA SHEET

Sheet ___ of ___

WELL DEVELOPMENT DATA SHEET

BORING NO. ___________ WELL NO. ___________

Project ________________________
Project No. ________________________
Date(s) of Installation ________________________
Date(s) of Development ________________________
Personnel/Company ________________________

Type of Rig Used ________________________

Casing Diameter/Type ________________________
Borehole Diameter ________________________
Screened Interval(s) ________________________
Total Length of Well Casing ________________________
Measured Total Depth (TOC) Initial ________________
Final ________________
Initial Depth to Water
(TOC) ____________ Date ________ Time ________
Stabilized Depth to Water
(TOC) ____________ Date ________ Time ________

DEVELOPMENT TECHNIQUE(S) EQUIPMENT TYPE/CAPACITY

____ Surging ________________________
____ Overpumping ________________________
____ Air Lift Pumping ________________________
____ Backwashing ________________________
____ Bailing ________________________
____ Well Jetting ________________________

FLUIDS ADDED

Lost Drilling Fluid: ____________ Gallons
Lost Purge Water: ____________ Gallons
Water During Installation: ____________ Gallons
Total Fluids Added: ____________ Gallons
Source of Added Water: ________________________
Sample Collected of Added Water: Y N
Sample Designation of Added Water: ________________

PURGE VOLUME CALCULATION

Casing Volume: __________ Ft. of water
x __________ Gallons/Foot
= __________ Gallons per Single Casing Volume
Sand Pack Volume: __________ Ft. of Saturated Sand Pack
x __________ Gallons/Foot (borehole diameter)
= __________ Gallons (in borehole)
- __________ Gallons of Casing Volume
= __________ x 0.3 (Assuming porosity = 30%)
= __________ Gallons Within Sand Pack
Single Purge Volume: __________ Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: __________ Gallons
Actual Purge Volume: __________ Gallons
Volume Measured by: ________________________
Rate of Development ________ Gallons/Minute (Hour, Day)
Pumping Rate/Depth __________ @ ______ Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness ____________

Development Criteria: ____

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity (NTU)	D.O., Clarity, Odor, PID Readings, Other:

Development Completed at ________________ Gallons Discharged. Date: __________ Time: __________

Personnel: ____

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Order 011

Prepared for

U.S. DEPARTMENT OF THE NAVY

Southwest Division
Naval Facilities Engineering Command
San Diego, California

QUALITY ASSURANCE PROJECT PLAN ADDENDUM FOR PHASE III GROUNDWATER DATA GAPS INVESTIGATION (ADDENDUM II) HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

DS.0011.17267

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COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
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REVIEW AND APPROVALS

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ABBREVIATIONS AND ACRONYMS

AOC	Area of concern
ARAR	Applicable or relevant and appropriate requirement
Bay	San Francisco Bay
bgs	Below ground surface
CLEAN II	Comprehensive Long-term Environmental Action Navy
CTO	Contract Task Order
DCB	Dichlorobenzene
DCE	Dichloroethene
DDT	Dichlorodiphenyltrichloroethane
DER	Duplicate error ratio
DHS	California Department of Health Services
DNAPL	Dense nonaqueous-phase liquid
DQA	Data quality assessment
DQO	Data quality objective
EPA	U.S. Environmental Protection Agency
Fe^{2+}	Ferrous iron
FS	Feasibility study
FSP	Field sampling plan
GDGI	Groundwater data gaps investigation
H_o	Null hypothesis
HGAL	Hunters Point groundwater ambient level
HPS	Hunters Point Shipyard
HSP	Health and safety plan
IDL	Instrument detection limit
IR	Installation Restoration
K-40	Potassium-40
µg/L	Microgram per liter
MCL	Maximum contaminant level
MDA	Minimum detectable activity
MNA	Monitored natural attenuation
MQO	Measurement quality objective
MS	Matrix spike
MSD	Matrix spike duplicate
msl	Mean sea level

ABBREVIATIONS AND ACRONYMS (Continued)

Navy	U.S. Department of the Navy
NRDL	Naval Radiological Defense Laboratory
PARCC	Precision, accuracy, representativeness, completeness, and comparability
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
pCi/g	Picocurie per gram
pCi/L	Picocurie per liter
POC	Point of compliance
PRC	PRC Environmental Management, Inc.
PRQL	Project-required quantitation limit
QA	Quality assurance
QAO	Quality assurance officer
QAPP	Quality assurance project plan
QC	Quality control
QCSR	Quality control summary report
RI	Remedial investigation
RPD	Relative percent difference
RU	Remedial unit
SOP	Standard operating procedure
SVOC	Semivolatile organic compound
TCE	Trichloroethene
TDS	Total dissolved solids
TIZ	Tidal influence zone
TMZ	Tidal mixing zone
TSS	Total suspended solids
TtEMI	Tetra Tech EM Inc.
VOC	Volatile organic compound

A1 INTRODUCTION

Tetra Tech EM Inc. (TtEMI) received Contract Task Order (CTO) Nos. 005 and 011 under Comprehensive Long-term Environmental Action Navy Contract No. N62474-94-D-7609 (CLEAN II) from the U.S. Department of the Navy (Navy), Naval Facilities Engineering Command, Southwest Division, to conduct a remedial investigation (RI) and continue through the record-of-decision activities at Parcels D and E (CTO 005) and Parcels B and C (CTO 011) at Hunters Point Shipyard (HPS) in San Francisco, California. TtEMI received subsequent modifications to CTOs 005 and 011 to evaluate data gaps for groundwater.

A phased approach is being used to implement the current groundwater data gaps investigation (GDGI). The Phase I GDGI was conducted at Parcels C and D at HPS from July 2000 to December 2000. The Phase I GDGI was conducted in accordance with the associated planning document, “Final Field Sampling Plan [FSP] and Quality Assurance Project Plan [QAPP] for Phase I Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California,” dated July 31, 2000 (TtEMI 2000a; also see Appendix A of the FSP addendum). The results of the Phase I GDGI were summarized in “Information Package for the Phase I Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California,” dated December 1, 2000 (TtEMI 2000c). A revised Phase I GDGI information package was submitted on January 8, 2001 (TtEMI 2001b) to address concerns discussed during a December 5, 2000, working meeting (Navy 2000).

The Phase II GDGI was conducted at Parcels C, D, and E at HPS from January 2001 to April 2001. The Phase II GDGI was conducted in accordance with the associated planning document, “Field Sampling Plan and Quality Assurance Project Plan Addenda for Phase II Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California,” dated January 8, 2001 (TtEMI 2001a; also see Appendix B of the FSP addendum). The results from the Phase II GDGI were summarized in three documents:

- “Parcel D Information Package Phase II Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California,” dated June 1, 2001 (TtEMI 2001c)
- “Parcel C Information Package Phase II Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California,” dated August 3, 2001 (TtEMI 2001d)
- “Parcel E Information Package Phase II Groundwater Data Gaps Investigation, Hunters Point Shipyard, San Francisco, California,” dated August 10, 2001 (TtEMI 2001e)

This QAPP addendum is a supplement to the final Phase I FSP/QAPP (TtEMI 2000a; see also Appendix A of the FSP addendum) and to the Phase II FSP/QAPP addenda (TtEMI 2001a; see also Appendix B of the FSP addendum). It documents all changes in policies, project organization, and quality assurance and quality control (QA/QC) procedures to be implemented for the Phase III GDGI at HPS Parcels C, D, and E. However, for brevity, sections of the Phase I and II GDGI QAPP with no changes will not be repeated in this QAPP addendum. Instead, those sections are noted herein as having "no change." Table A-1 summarizes significant changes in this QAPP addendum.

TABLE A-1

SIGNIFICANT CHANGES TO QUALITY ASSURANCE PROJECT PLAN ADDENDUM FOR PHASE III GROUNDWATER DATA GAPS INVESTIGATION

Change to QAPP	Section of QAPP
Characterization of the B-aquifer is complete in Parcel D.	A1, A3
In Parcel D, the A-aquifer will be characterized only in IR-22.	A1, A3
Hydraulic tests will be conducted in four locations in Parcel C and in two locations in Parcel E.	A1, A3
Tidal influence and tidal mixing zone studies (optional) will be conducted in Parcels C, D, and E.	A1, A3
A data gaps study for radionuclides in the A-aquifer will be conducted in Parcels B, C, D, and E.	A1, A3
Sampling for analysis of MNA parameters is eliminated from approximately 100 wells in Parcels C and E.	A1, A3
New monitoring wells will be installed in Parcels C and E for supplemental groundwater characterization, hydraulic testing, tidal studies, and to replace decommissioned wells.	A1, A3
SWRCB analytes for solid waste landfills were added to 20 wells within IR-01/21, Parcel E.	A1, A3
Twelve wells were added for sampling in IR-06.	A1, A3

Notes:

IR Installation Restoration
MNA Monitored natural attenuation
QAPP Quality assurance project plan
SWRCB State of California Water Resources Control Board

This QAPP addendum (and the QAPP for the Phase I and II GDGIs) fully describes the project data quality objectives (DQO) that have been developed through the seven-step DQO process (U.S. Environmental Protection Agency [EPA] 2000a) in accordance with EPA guidance for preparation of QAPPs (EPA 1998). Section A1.1 describes the format of the plan. Section A1.2 describes the proposed use of this QAPP, and Section A1.3 provides background information about the groundwater investigation. Section A1.4 describes the seven-step process used to define the DQOs for this project. Tables are presented where they are first cited in the text, whereas figures follow the text and the references. This QAPP addendum and the accompanying FSP addendum form the sampling and analysis plan addendum. Both documents are included in the same binder for easy reference. Field crews are required to keep hard copies of the FSP and QAPP for the Phase I, II, and III GDGIs on hand at all times.

A summary of the site background and the results of previous investigations is presented in this QAPP, whereas more detailed background and an analysis of site information are presented in the RI reports (PRC Environmental Management, Inc. [PRC] 1996a, 1996b, 1997a, 1997b) and the feasibility study (FS) reports (PRC 1996c, 1997c; TtEMI 1998a,1998b) for Parcels B, C, D, and E. All field activities in support of data collection and measurement for the Phase III GDGI will be conducted in accordance with TtEMI's "CLEAN II Program Health and Safety Plan [HSP], Revision I" (PRC 1995) and the basewide HSP (TtEMI 2000b).

A1.1 DOCUMENT REQUIREMENTS AND FORMAT

The format of this QAPP conforms to specifications set forth in "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations," EPA QA/R-5 (EPA 2001) and "Guidance for the Data Quality Objectives Process," EPA QA/G-4 (EPA 2000a). EPA QA/R-5 states that the requirements for QAPPs include (1) evaluating the DQOs for the project, (2) ensuring that intended measurements and data acquisitions are appropriate, (3) ensuring that QA/QC procedures are adequate to confirm data quality, and (4) identifying limitations on the use of the data. Table A-2 summarizes the elements of this QAPP.

TABLE A-2

ELEMENTS OF QUALITY ASSURANCE PROJECT PLAN

Element of QAPP	EPA QAPP[a] Section Number	This QAPP Section Number
A. Project Management		
Title and approval sheet	A1	Page i
Table of contents	A2	Page ii
Distribution list	A3	Cover letter
Project/task organization	A4	A2
Problem definition/background	A5	A1, A3
Project/task description	A6	A4
Quality objectives and criteria for data measurement	A7	A5
Special training/certification	A8	A2.3
Documentation and records	A9	A6
B. Measurement/Data Acquisition		
Sampling process design (experimental design)	B1	B2
Sampling methods	B2	B3
Sample handling and custody	B3	B4
Analytical methods	B4	B5
Quality control	B5	B6
Instrument/equipment testing, inspection, and maintenance	B6	B7
Instrument/equipment calibration and frequency	B7	B7, B8
Inspection/acceptance of supplies and consumables	B8	B8
Nondirect measurements	B9	B9
Data management	B10	B9.3
C. Assessment/Oversight		
Assessments and response actions	C1	C1
Reports to management	C2	C1.3
D. Data Validation and Usability		
Data review, verification, and validation	D1	D1
Verification and validation methods	D2	D2
Reconciliation with user requirements	D3	D2

Notes:

a EPA. 2001. "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations." Interim Final. EPA QA/R-5. March.

EPA U.S. Environmental Protection Agency
QAPP Quality assurance project plan

A1.2 USE OF THE DOCUMENT

Each element of the QAPP is discussed in this document as it pertains to the Phase III GDGI. The QAPP provides specific guidance and QA/QC criteria for collecting, evaluating, and submitting data while the project is completed. To ensure the quality and usability of the data collected, all personnel who work on the project are required to read and comply with the procedures set forth in this document.

A1.3 BACKGROUND

Background information about HPS and the GDGI are presented in the sections below. Section A3 summarizes site-specific background information and analytical results. Detailed background information, such as information about site-specific operational histories, environmental restoration activities, and the results of environmental investigation and analysis, is presented in the Parcels B, C, D, and E RI reports (PRC 1996a, 1997a, 1996b, 1997b, respectively).

A1.3.1 Facility Location

No change.

A1.3.2 Facility Background

HPS operated as a commercial dry dock facility from 1869 until December 29, 1939, when the Navy purchased the property. From 1945 until 1974, the Navy built ships and modified, maintained, and repaired submarines at HPS. The Naval Radiological Defense Laboratory (NRDL) operated at HPS from 1948 until it was disestablished in 1970. In 1974, the Navy ceased shipyard operations at HPS, placed the facility in industrial reserve, and transferred control of the property to its Office of the Supervisor of Shipbuilding, Conversion, and Repair in San Francisco. Triple A Machine Shop leased most of HPS from the Navy from May 1976 to June 1986 and operated a commercial ship repair facility.

A1.3.3 Phase III Groundwater Data Gaps Investigation

The Phase III GDGI consists of six discrete tasks, as described further in the accompanying FSP addendum:

1. Measure basewide water levels to construct a groundwater potentiometric surface map from data collected at existing A- and B-aquifer wells.

2. Further characterize potential groundwater contamination in the B-aquifer in Parcels C and E by sampling existing and newly installed wells, and evaluating hydrogeologic parameters (including yield, hydraulic conductivity, horizontal gradient, and vertical gradient).

3. Further characterize the nature and extent of contamination by resampling A-aquifer and bedrock water-bearing zone wells in Parcels C, D, and E for analysis of chemical parameters.

4. Conduct hydraulic tests at four A-aquifer wells in Parcel C and two A-aquifer wells in Parcel E to assess hydrogeologic parameters of the A-aquifer and the degree of hydraulic connection between the A- and B-aquifers and bedrock water-bearing zone.

5. Collect continuous water level and electrical conductivity data using transducers from shallow groundwater monitoring wells in the zone of tidal influence.

6. Collect two rounds of groundwater sampling for 36 monitoring wells included in the data gaps study of radionuclides in shallow groundwater at HPS.

The Phase III GDGI is intended to provide additional data for the revised FS reports for Parcels C, D, and E. The revised FS reports will include an evaluation of the beneficial uses of groundwater. The Navy evaluated historical groundwater data for Parcels C, D, and E, which indicated analytes at concentrations exceeding drinking water standards (that is, the most stringent federal or state primary maximum contaminant levels [MCL]), and the likelihood that the A-aquifer would be used as a drinking water source (TtEMI 2001f). The Navy also developed revised remedial units (RU) for groundwater at Parcels C and D based on historical concentrations of analytes in samples from groundwater monitoring wells that exceeded drinking water standards or ambient groundwater levels. The Navy proposed further evaluation of those areas. In addition, a working meeting to evaluate groundwater data gaps in Parcel E was conducted on November 7, 2000. Based on the recommendations made during the working meetings, the Navy developed the scope of work for the Phase III GDGI, as presented in this QAPP addendum and the accompanying FSP addendum.

A1.4 DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements developed through the seven-step DQO process (EPA 1999, 2000a). The primary outputs of the iterative methodology are (1) definition of the problem under investigation, (2) identification of the decisions that require inputs and resolution, (3) identification of the inputs, (4) delineation of the study boundaries, (5) development of decision rules, (6) specification of tolerable limits on errors, and (7) optimization of the sampling design. These seven steps are detailed below.

Step 1 – State the Problem

Step 1 of the DQO process identifies the specific problem(s) to be solved or the decision to be made. Six specific problems that require investigation in the data gaps study for groundwater at HPS are identified under Step 1 in Sections A1.4.1 through A1.4.6.

Step 2 – Identify the Decision

Step 2 of the DQO process identifies the questions that the investigation will attempt to answer and considers alternative actions that may be taken. Decision rules (Step 5) that correspond to each decision statement listed under Step 2 provide the conditions under which alternative actions may be taken based on the various possible outcomes of the investigation. At least one decision statement is provided for each of the six studies scheduled for the Phase III GDGI.

Step 3 – Identify the Inputs to the Decision

Step 3 describes the information to be obtained and the measurements that need to be collected to resolve the decision statements. At least one decision statement is provided for each of the six studies scheduled for the Phase III GDGI.

Step 4 – Define the Study Boundaries

The spatial and temporal boundaries of the proposed investigations are described in Step 4 of the DQO process. These boundaries establish the limits for where and when the data are to be collected. Spatial boundaries delimit the horizontal and vertical extent of the study area.

Step 5 – Develop a Decision Rule

Step 5 of the DQO process defines the statistical parameter of interest, specifies the action level, and integrates study outputs into a single statement that describes the logical basis for choosing among alternative actions. Step 5 essentially delineates the consequences of the results of the study. Decision rules may be formulated as "if . . . then" statements, in which the outcome of the investigation provides direction for the next stage of problem resolution. For example, if contamination is not detected, the site may proceed to no further action; however, if contamination is found, the site may proceed to remediation or further investigation.

In particular, the investigator should confirm that the specified action levels are greater than the detection and quantitation limits identified in Step 3, Identify the Inputs to the Decision. Analytical methods should be selected with both action levels and budgetary constraints in mind.

Step 6 – Specify Limits on Decision Errors

Step 6 of the DQO process quantifies (where possible) the acceptable limits on decision errors. Quantification of decision errors is possible for data collected using a probability-based sampling design but may not be possible in the case of a nonprobability-based (that is, judgmental) sampling design. For judgmental sampling, the limits may be qualitative. The quantitative limits for statistically based data are needed to establish the level of uncertainty that will be acceptable to and agreed on by all stakeholders (such as regulatory agencies, citizens, and site owners). The acceptable level of error should be based on a consideration of the consequences of making an incorrect decision; that is, the consequences of both false-positive and false-negative errors should be evaluated.

The quality of the analytical data is also assessed under this step. Typically, the quality assessment involves specification of performance criteria in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the data. The performance criteria, termed the PARCC parameters, are discussed in Section A5.5 of this QAPP.

Statistical parameters cannot be specified in every case; however, measurement quality objectives (MQO) in the form of precision and accuracy goals (discussed in Section A5.5) are designed to minimize analytical errors.

Step 7 – Optimize the Design for Obtaining Data

Step 7 of the DQO process identifies a resource-effective design for generating environmental data that will meet the DQOs discussed in the previous sections. Several factors were evaluated in developing the sampling scheme for this groundwater investigation monitoring program. These factors included monitoring well locations, sampling frequency, and analytes of concern.

Under this groundwater investigation, analyses are proposed for specific analytes or suites of analytes: volatile organic compounds (VOC), semivolatile organic compounds (SVOC), pesticides and polychlorinated biphenyls (PCB), dissolved metals, hexavalent chromium, organophosphates, cyanide, ammonia nitrogen, total kjeldhal nitrogen, sulfide, total suspended solids (TSS), and radionuclides and monitored natural attenuation (MNA) parameters. Radionuclides include americium-241; cesium-137; cobalt-60; europium-152 and –154; potassium-40 (K-40); radium-226 and –228; strontium-90; tritium; and uranium-233, -235, and –238. MNA parameters include ferrous iron (Fe^{2+}), ferric iron, manganese (II), nitrate, nitrite, sulfate, dissolved oxygen, oxidation-reduction potential, chloride, total alkalinity, hydroxide alkalinity, carbonate, bicarbonate, calcium, magnesium, sodium, potassium, and total dissolved solids (TDS). The analytes of concern for groundwater samples (that is, sampling suites) were selected based on knowledge of potential contaminant source areas and the laboratory analytical results from previous groundwater samples.

In Sections A.1.4.1 through A.1.4.6 and Table A-3, the seven DQO steps are described for each of the six general tasks to be performed in the Phase III GDGI.

A1.4.1 Water Level Measurements

Step 1 – State the Problem

Additional groundwater potentiometric surface maps are needed to assess the current groundwater flow conditions in the A-aquifer, to evaluate seasonal effects, and to confirm the existence of anomalies identified on previous maps that may indicate broken or leaking utility lines.

Step 2 – Identify the Decision

Can groundwater potentiometric surface maps be constructed that are representative of the A-aquifer such that:

1. The general groundwater flow pattern can be identified, and
2. Preferential pathways for groundwater flow (sources or sinks) can be identified?

Step 3 – Identify the Inputs to the Decision

Water levels will be measured at approximately 280 existing wells. Water level data will be used to define the current groundwater potentiometric surface using the following:

- An appropriate numeric interpolation technique
- Modification by a California-registered geologist
- Underground utility line maps
- TDS and salinity information for density correction

Step 4 – Define the Study Boundaries

The areal limits for measurements of water levels consist of A-aquifer wells previously sampled at HPS. The vertical limit for water levels measurements is the depth of the wells installed in the A-aquifer at

HPS. The temporal limit of a single measurement event is a period that will begin 1 hour before a high or low tide and will not extend beyond 3 hours after the high or low tide. Subsequent water level measurement may be conducted to account for seasonal variations.

Step 5 – Develop a Decision Rule

Decision rules for the two decisions identified in Step 2 are as follows:

(1a) If the groundwater potentiometric surface map can be used to identify the general groundwater flow pattern, these data will be described in the GDGI report and used in the revised FSs to help evaluate groundwater flow and contaminant fate and transport.

(1b) If the groundwater potentiometric surface map cannot be used to identify the general groundwater flow pattern based on professional judgment, new wells or piezometers will be installed and additional water level data will be collected to fill data gaps.

(2a) If the interpretation of groundwater potentiometric surface maps indicates preferential contaminant flow to San Francisco Bay (Bay) due to utility lines (such as groundwater mounds indicating water pipe leaks or groundwater sinks indicating groundwater entering the storm drain lines), utility lines will be identified for repair, if necessary.

(2b) If the interpretation of groundwater potentiometric maps does not indicate preferential flow of contaminants to the Bay due to utility lines, further evaluation of utility lines is not required.

Step 6 – Specify Limits on Decision Errors

All decisions concerning the interpretation of hydrological data are judgmental and are based on the best professional judgment. Because all decisions are subjective, it is not possible to quantify the error rates. Possible decision errors include errors in water level measurements, which may lead to incorrect assumptions (that is, decision errors) about the direction of groundwater flow. The water level measurements are required to be accurate to plus or minus 0.01 feet and are repeated three times.

Step 7 – Optimize the Design for Obtaining Data

Well locations are selected to provide general coverage across HPS, with a focus on individual RUs. Based on professional judgment and using numeric interpolation techniques, a California-registered geologist may identify areas where water level measurement data coverage is not sufficient to identify groundwater flow patterns with reasonable certainty. In locations where water level measurement data coverage is not sufficient, additional wells may be installed to assess groundwater potentiometric surface, as appropriate. Water level measurements will be collected during a period of relatively low tidal fluctuation in the Bay. The period of lowest fluctuation during a 28-day lunar cycle is best, but may not be convenient because the high and low tides may occur at night. A period of low fluctuation that allows water level measurement during daylight hours will be selected. The sampling design is described in further detail in the FSP addendum.

A1.4.2 B-Aquifer Study

Step 1 – State the Problem

The extent of contamination in the B-aquifer and its relationship to contaminant plumes that emanate from the A-aquifer groundwater in Parcels C and E has not been evaluated because chemical and hydrogeologic data are insufficient to support an evaluation.

Step 2 – Identify the Decision

Do plumes of VOCs and other contaminants found in the A-aquifer extend into the B-aquifer, thereby indicating a hydraulic connection between the aquifers at that location?

Step 3 – Identify the Inputs to the Decision

Samples of groundwater collected from existing B-aquifer wells (including two nested A- and B-aquifer well pairs) and new nested wells will be analyzed to provide validated chemical data. Soil samples collected from installing new nested A- and B-aquifer well pairs will be analyzed for porosity, hydraulic conductivity, and geologic characteristics. Chemical data will be mapped in both plan and hydrogeological cross-section views to establish the lateral extent of contamination and potential migration pathways to the B-aquifer.

Step 4 – Define the Study Boundaries

The areal limits of the B-aquifer study area are the boundaries of the A-aquifer groundwater areas of concern (AOC) in Parcels C and E. The vertical limit of the B-aquifer study area is a depth of 5 feet below the bottom of the B-aquifer or to the bottom of VOC or other contamination, whichever is less. The temporal limit of the B-aquifer study is approximately 2 months (when the wells will be sampled once). Additional phases of the B-aquifer study may be conducted to account for seasonal variations.

Step 5 – Develop a Decision Rule

The decision rules for the decision identified in Step 2 are as follows:

- If chemical data indicate that contamination in the A-aquifer has migrated to the B-aquifer and is not adequately characterized, additional sampling locations will be proposed to characterize the vertical and areal extent of the plume in the B-aquifer and the conceptual model will be updated.

- If chemical data indicate that the B-aquifer in the area does not contain analytes at concentrations exceeding the most stringent primary MCL or Hunters Point groundwater ambient level (HGAL) (or aquatic criterion, as applicable), characterization of contamination in the B-aquifer will be considered complete.

Step 6 – Specify Limits on Decision Errors

MQOs in the form of precision and accuracy goals (Section A5.5) are designed to minimize analytical errors. Chemical data will be quantitatively evaluated; however, the sampling design is judgmental rather than probabilistic, so tolerable limits on decision errors cannot be rigorously quantified.

Step 7 – Optimize the Design for Obtaining Data

Groundwater samples will be collected from B-aquifer wells in Parcels C and E. These samples will be the second round for these wells. Two rounds of groundwater data have been collected in B-aquifer wells at Parcel D, and these wells will not be resampled in the Phase III GDGI. Locations for new nested A- and B-aquifer well pairs are selected using the following guidelines:

- Wells will be placed near areas of known contamination in the A-aquifer (as discussed in the working meetings in February and March 2000).

- Wells will be placed to best define potential migration of contaminants in areas where Bay Mud does not separate the A- and B-aquifers.

- If direction of groundwater flow in either the A- or B-aquifer can be estimated, wells will be placed downgradient of known areas of contamination.

A1.4.3 A-Aquifer and Bedrock Water-Bearing Zones

Step 1 – State the Problem

Groundwater AOCs in the A-aquifer and bedrock water-bearing zones were identified based on data collected more than 4 years ago and may not reflect current conditions.

Step 2 – Identify the Decision

1. Are the lateral extents of the contaminant plumes in the A-aquifer AOCs correctly characterized based on current conditions?

2. Do the contaminant plumes extend into the bedrock water-bearing zones at any location, thereby indicating a hydraulic connection at that location?

Step 3 – Identify the Inputs to the Decision

Inputs to the decisions identified in Step 2 are as follows:

- Current chemical data (with detection limits below potential applicable or relevant and appropriate requirements [ARAR]) for analytes of potential concern in groundwater collected from existing wells screened in the A-aquifer and bedrock water-bearing zones.

- Chemical data mapped in both plan and hydrogeological cross-section views (to be used to help illustrate the lateral extent of contamination and potential migration pathways to the bedrock water-bearing zones).

- Previously collected chemical data for groundwater.

Step 4 – Define the Study Boundaries

The areal limit of the study of the A-aquifer and bedrock water-bearing zones are the lateral extents of the contaminant plumes that emanate from A-aquifer groundwater at Parcels C and E. The vertical limit of the study of the A-aquifer and bedrock water-bearing zones is the thickness of the A-aquifer and the depth of the bedrock wells or to the bottom of the contamination, whichever is less. The temporal limit of the study of the A-aquifer and bedrock zones is 2 months (when the wells will be sampled once). Additional phases of this study may be conducted to account for seasonal variations.

Step 5 – Develop a Decision Rule

Decision rules for the decisions identified in Step 2 are as follows:

(1a) If chemical data indicate that the horizontal extent of contamination in the A-aquifer is not adequately characterized for current conditions, additional sampling locations will be proposed to improve the characterization of the horizontal extent of the contaminant plume in the A-aquifer and to update the conceptual model.

(1b) If chemical data indicate that the horizontal extent of contamination in the A-aquifer is adequately characterized, horizontal characterization of contamination in the A-aquifer will be considered complete.

(2a) If the chemical data indicate that contamination has migrated from the A-aquifer to the bedrock water-bearing zones, additional sampling locations will be proposed to characterize the horizontal and vertical extent of the plume in the bedrock water-bearing zones and the conceptual model will be updated.

(2b) If the chemical data indicate that contamination has not migrated from the A-aquifer to the bedrock water-bearing zones, characterization of contamination in the bedrock water-bearing zones will be considered complete.

Step 6 – Specify Limits on Decision Errors

MQOs in the form of precision and accuracy goals (Section A5.5) are designed to minimize analytical errors. Chemical data will be quantitatively evaluated; however, the sampling design is judgmental rather than probabilistic, so tolerable limits on decision errors cannot be rigorously quantified.

Step 7 – Optimize the Design for Obtaining Data

A-aquifer wells and bedrock water-bearing zone wells have been sampled for two rounds in Parcels C and D and one round in Parcel E. For the Phase III GDGI, A-aquifer wells will be sampled throughout Parcels C and E and in Installation Restoration (IR) site 22 in Parcel D. Bedrock water-bearing zone wells will be sampled in Parcels C and E. Data for additional parameters may be collected to support remedial decisions and to evaluate technologies in the FS. The following criteria will be used to select wells for additional sampling:

- Wells within RUs identified previously (based on ecological risk and human health risk via the inhalation exposure pathway) will be selected for resampling.
- Certain wells surrounding previously identified RUs will be selected for resampling if historical data indicate chemicals are present at concentrations that exceed MCLs, HGALs, or aquatic criteria.
- Certain wells with isolated detections of chemicals at concentrations that exceed MCLs, HGALs, or aquatic criteria will be selected for resampling.

Some wells surrounding RUs identified previously will be selected for resampling even if their historical data do not indicate the presence of analytes at concentrations that exceed MCLs, HGALs, or aquatic criteria. These wells will be selected to evaluate (1) the extent of the current RUs and (2) the potential for plume migration.

A1.4.4 Hydraulic Tests

Step 1 – State the Problem

In AOCs in Parcels C and E, the following aquifer hydraulic characteristics are not sufficiently understood:

- Hydraulic connection between the A- and B-aquifers and bedrock water-bearing zones
- Aquifer transmissivity and storativity
- Potential well yield

Step 2 – Identify the Decision

1. Is there significant hydraulic connection between the A-aquifer and the B-aquifer or bedrock water-bearing zones based on professional judgment using data from pumping tests? If a connection exists, what is the nature of the connection?
2. Does the potential well yield exceed the federal criterion for beneficial use as a drinking water supply?

Step 3 – Identify the Inputs to the Decision

The inputs to the decisions identified in Step 2 are as follows:

- Water levels measured in pumping and observation wells during pumping tests
- Values of aquifer parameters (leakance, transmissivity, storativity, and hydraulic conductivity) estimated using pumping test data
- Water levels measured in pumping and observation wells during step-drawdown tests
- Values of potential well yield calculated using data from step-drawdown and constant rate tests

Constant rate pumping test results will be used to evaluate the degree of hydraulic connection among aquifer zones. Water level responses in pumping wells will be compared with the responses in observation wells. The degree of response in an observation well together with the spatial and hydrostratigraphic position of the screen in the observation well relative to the screen in the pumping well will be used to establish the degree of hydraulic connection between the well screen intervals in the pumping and observation wells.

For observation wells screened in the same hydrostratigraphic unit as the pumping well and located at equal distances from the pumping well, larger water level responses to pumping signify a larger degree of hydraulic connection between the pumping and observation screen intervals. Interpretations of water level data are not as straightforward for observation wells that are not screened in the same hydrostratigraphic unit as the pumping well or for comparing observation wells that are at significantly different distances from the pumping well. In such cases, professional judgment will be used to interpret the relative degrees of hydraulic connection. Water level data from an observation well located adjacent to a pumping well but screened at different elevation than the pumping well will be used to calculate aquifer leakance, a parameter that quantifies the vertical hydraulic connection between hydrostratigraphic units.

Aquifer transmissivity, storativity, and hydraulic conductivity calculated from constant-rate pumping test data will provide realistic input for fate and transport evaluation. Analyte concentrations at receptor locations predicted by fate and transport models will be compared with applicable regulatory criteria to determine whether human health or aquatic life concerns exist.

Water level data from step-drawdown pumping tests will be used to estimate potential well yield for the aquifer zones in which the pumping wells are screened. The well yields will be compared with existing well yield standards to determine the beneficial use of the groundwater. The well yields will also provide a design basis for treatability studies and groundwater remediation pilot studies, if such studies are deemed necessary.

Step 4 – Define the Study Boundaries

Hydraulic testing will target the AOCs in Parcels C and E. The vertical limits of hydraulic testing are the B-aquifer zone or shallow bedrock. The temporal limit for hydraulic testing is 2 months.

Step 5 – Develop a Decision Rule

Decision rules for the decisions identified in Step 2 are as follows:

(1a) If there is significant hydraulic connection between the A-aquifer and B-aquifer or bedrock water-bearing zones, further investigation will be considered to define the potential impacts of A-aquifer contamination on groundwater in the B-aquifer and bedrock water-bearing zones.

(1b) If there is not significant hydraulic connection between the A-aquifer and the B-aquifer or bedrock water-bearing zones, no further investigation is necessary to define the potential impacts of A-aquifer contamination on groundwater in the B-aquifer zone.

(1c) If the evaluation of the test data yields inconclusive results about the possible hydraulic connection between the A-aquifer and B-aquifer, additional aquifer testing may be conducted.

(2a) If step-drawdown and constant-rate tests results show that the long-term potential well yield of an aquifer zone equals or exceeds federal beneficial use criterion, that aquifer zone will be considered to have sufficient potential yield for a residential drinking water supply based on the federal beneficial use criterion.

(2b) If step-drawdown test results show that the potential well yield of an aquifer zone does not exceed the federal beneficial use criterion, that aquifer zone will be considered to have insufficient potential yield for a residential drinking water supply based on the federal beneficial use criterion.

Step 6 – Specify Limits on Decision Errors

Because decisions on aquifer hydraulic connection will be made using professional judgment, tolerable limits on decision errors cannot be quantified. The accuracy of water level measurement instruments and measuring point elevation surveys should be plus or minus 0.01 foot.

Step 7 – Optimize the Design for Obtaining Data

Wells for the pumping tests will be selected based on the following criteria:

- Location in areas of known A-aquifer contamination
- High yield
- Screened in permeable zone

Water levels in A- and B-aquifer and bedrock water-bearing zone wells will be monitored during the tests. These wells will be selected based on proximity to the A-aquifer pumping wells.

Data from the step-drawdown tests will be plotted in the field, and step changes will be made at the direction of the supervising hydrogeologist. The data from the step-drawdown tests will be interpolated to determine (1) the optimum pumping rate for 72-hour constant-rate pumping tests to be conducted at each pumping well and (2) the potential well yield.

Data from the constant-rate pumping tests will also be plotted in the field. The test may be terminated at the direction of the supervising hydrogeologist; at which time, collection of recovery data will begin.

A1.4.5 Preferential Flow and Tidal Studies

Step 1 – State the Problem

The preferential flow patterns in shallow groundwater near the shoreline at HPS are not well understood and may be masked by tidal influence. This understanding is needed to evaluate contaminant migration pathways from groundwater AOCs to the Bay.

The extent of the tidal mixing zone (TMZ) is not defined and may be helpful in defining the point of compliance (POC).

Step 2 – Identify the Decision

1. Can preferential pathways of groundwater flow be identified after filtering out the tidal influence in shallow groundwater at HPS?

2. Do selected wells within the tidal influence zone (TIZ) experience tidal mixing, as measured by changes in the electrical conductivity of groundwater in those wells? (This is an optional investigation that will be conducted only if deemed necessary to help identify the POC.)

Step 3 – Identify the Inputs to the Decision

The inputs to the decisions identified in Step 2 are as follows:

- Continuous water level data from existing shallow monitoring wells and piezometers and newly installed piezometers in areas of potential tidal influence. (These data will be used to determine the mean groundwater elevations at each of the wells measured.)

- Continuous water elevation data from a surface water station in the Bay. (These data will be used to determine the mean surface water elevation in the Bay.)

- The flow path for groundwater will be determined from mean elevations of groundwater.

- Tidal efficiencies and time lags will also be determined from the elevation data that will be continuously collected for surface water and groundwater, as described above. (The tidal efficiencies and time lags will allow the calculation of future mean groundwater elevations using single water level measurements.)

- Continuous data for electrical conductivity in groundwater from selected shallow monitoring wells within the TIZ. (This is an optional investigation that will be conducted only if deemed necessary to help identify the POC.)

Mean groundwater elevations will be calculated from the tidal study data by using the tidal effects filtering method of Serfes (1991). The mean groundwater elevations will be used to define groundwater flow patterns near the shore. The flow patterns will be used as input to the fate and transport evaluation.

Using the tidal study water levels, the tidal influence parameters (tidal efficiency and time lag) will be quantified for each well included in the tidal study. With this information, the inland extent of tidal pressure influence will be defined. The tidal influence parameters will be used to convert future single groundwater level measurements to mean groundwater elevations without the multiple water level measurements required for filtering tidal effects. Future measurements will be used to define groundwater flow patterns and those patterns will be compared with patterns defined with earlier data to assess if changes in flow patterns have occurred.

Step 4 – Define the Study Boundaries

The areal limit of the tidal studies extends from the Bay shoreline to approximately 400 feet inland, within the boundaries of Parcels B, C, D, and E. The station for measurement of surface water elevations in the Bay will be located near Building 253, which is in Parcel C. The vertical limit of the tidal studies is constrained to the cumulative thickness of the A-aquifer, B-aquifer, and bedrock water-bearing zones. The temporal limit of the tidal studies is approximately 2 months. The temporal limit for the tidal study at a specific groundwater AOC is 7 days.

Step 5 – Develop a Decision Rule

Decision rules for the decisions identified in Step 2 are as follows:

(1a) If, based on professional judgment, data for the mean elevation of groundwater (that is, with tidal effects filtered out) indicate that groundwater flowing from an AOC is affected or influenced by a storm drain or sewer line, the fate and transport evaluation will use the flow path from the AOC to the storm drain line as the effective travel distance for contaminant migration from the AOC to the Bay. In addition, utility lines will be identified for repair, if necessary, and new water level measurements will be conducted.

(1b) If, based on professional judgment, data for the mean elevation of groundwater indicate that groundwater flowing from an AOC is not intercepted by a storm drain line, the fate and transport evaluation will use the flow path from the AOC to the Bay as the travel distance for contaminant migration and further evaluation of utility lines in that area will be considered complete.

(2a) If, based on professional judgment, electrical conductivity values for a particular well fluctuate with a pattern that correlates with the tide, that well will be considered to be within the TMZ.

(2b) If, based on professional judgment, electrical conductivity values for a particular well do not fluctuate with a pattern that correlates with the tide, that well will be considered to be outside of the TMZ.

Step 6 – Specify Limits on Decision Errors

Because decisions on tidal mixing and near-shore flow patterns will be made using professional judgment, tolerable limits on decision errors cannot be quantified. The accuracy of water level measurement instruments and measuring point elevation surveys is usually plus or minus 0.01 foot. The accuracy of electrical conductivity measurement instruments is plus or minus 0.05 percent.

Step 7 – Optimize the Design for Obtaining Data

Wells and piezometers to be monitored for tidal influence and tidal mixing will be selected based on the following criteria:

- Located within the TIZ
- Located near groundwater sinks and mounds
- Located near storm sewer lines that are below the water table

Groundwater levels will be measured at 15-minute intervals for 7 to 10 days. Surface water levels will be measured at 15-minute intervals for the duration of the tidal studies.

Electrical conductivity will be measured at 1-hour intervals for 7 to 10 days. (This is an optional investigation that will be conducted only if deemed necessary to help identify the POC.)

A1.4.6 Radiological Data Gaps Study

Step 1 – State the Problem

Areas of radioactively contaminated soils have been identified and removed from HPS; however, existing data for radionuclides and radiogenic indicator parameters (gross alpha and gross beta) in samples of sitewide groundwater and soils and groundwater collected in Parcel E do not provide sufficient coverage and specificity to make remedial decisions for groundwater. Data are also limited for local background activities of specific radioisotopes.

Isotope-specific data for groundwater are needed to evaluate whether site-related radioactive contamination occurs in groundwater at HPS, and if so, to delineate the extent of groundwater contamination.

Step 2 – Identify the Decision

1. Do the levels of radionuclide species in groundwater from Parcel E or elsewhere at HPS exceed regulatory limits?

2. Do the activities of radionuclide species in groundwater from background areas (including seawater) exceed regulatory limits?

3. Has groundwater in areas of radioactively contaminated soils been affected by site-related radionuclides that leached from soils and into shallow groundwater, so that activities are significantly above background levels?

4. Are high activities of gross beta reported in the existing data set the result of naturally occurring K-40 derived from sea water (K-40 mean equals 300 picocuries per liter [pCi/L]) or are the beta activities the result of site-related radionuclides?

Step 3 – Identify the Inputs to the Decision

The inputs to the decisions identified in Step 2 are as follows:

- New and existing analytical data (validated and defensible) for specific radionuclides in samples of shallow groundwater collected from wells near areas of radioactively contaminated soils and from background areas within and outside of HPS, including sea water.

- Historical documentation and personnel knowledge on the handling, treatment, and storage of radioactive materials at HPS.

- Supporting data for groundwater samples, including TSS, TDS, pH, and conductivity.

- Background data reported in the literature for radionuclides and radiological indicators.

- Hydrogeologic information, including water level, gradient, seasonal fluctuations, and directions of flow.

- Information on well construction, depth of screened intervals, and well production volumes.

- Regulatory screening levels or potential ARARs for radionuclides.

- Knowledge of the geochemical behavior of various radioactive elements.

Step 4 – Define the Study Boundaries

The lateral boundary of the study area includes wells throughout HPS and off-site areas for additional background samples.

The vertical boundary of the study extends from ground surface and into shallow groundwater. The temporal boundary of the study is constrained by the period of performance, which is estimated to be 5 months.

Step 5 – Develop a Decision Rule

Decision rules for the decisions identified in Step 2 are as follows:

(1a) If levels of radionuclides in site samples of groundwater exceed regulatory limits, site data will be compared with background data.

(1b) If levels of radionuclides in site samples of groundwater do not exceed regulatory limits, groundwater will not be further evaluated.

(2a) If background radioactivity exceeds regulatory limits, cleanup goals for radioactivity in groundwater at HPS will be established, so the Navy is not held to cleanup to levels below background.

(2b) If background radioactivity does not exceed regulatory limits, standard site-to-background statistical comparisons will be performed to evaluate whether site radioactivity exceeds background levels for groundwater.

(3a) If analytical data show statistically significant differences in the activities of radionuclides in site and background groundwater, site groundwater in the area will be further evaluated and further action may be recommended.

(3b) If analytical data show statistically indistinguishable activities of radionuclides in site and background groundwater, site groundwater in the area will be considered not contaminated and further action will not be recommended.

(4a) If gross beta activity correlates strongly with naturally occurring activities of K-40 in sea water, gross beta will not be used as an indicator for site-related effects. Rather, isotope-specific analyses are needed to distinguish the natural or site-related source of beta activity in site groundwater.

(4b) If gross beta activity shows no correlation with naturally occurring activities of K-40, gross beta may be used as an indicator for site-related effects to site groundwater.

Step 6 – Specify Limits on Decision Errors

MQOs will be established for sample analysis, and the analytical data will undergo QA/QC review to ensure that MQOs are met.

Appropriate parametric or nonparametric one-sample or two-samples tests will be used to compare radionuclide activities with cleanup levels or with a background population that has a goal of 95 percent level of confidence (that is, the null hypothesis [H_o] that the site data do not exceed regulatory limits [one-sample tests] or that data sets are taken from the same population [two-sample tests] will be rejected if the p-value for the statistical test is less than 0.05).

Two general types of statistical tests may be applied to evaluate whether site levels exceed cleanup or background levels:

- In cases where statistical tests compare one population against a fixed value, the tests are called "one-sample" tests. These tests, which are described fully in EPA guidance (EPA 2000b), may be used to evaluate the activities of radionuclide species in site samples of groundwater. A one-sample t-test or other appropriate statistical test will be applied to the data to ascertain whether the mean activities of radionuclide species in site groundwater exceed cleanup levels. H_o in this case is that site media contain levels of radionuclide activities that exceed cleanup levels. This hypothesis will be tested at the 95 percent confidence level, with a minimum of 80 percent power. These goals for confidence and power mean that a 5 percent chance exists of making a Type I error (rejecting H_o when it is, in fact, true) and a 20 percent chance exists of making a Type II error (accepting H_o when it is, in fact, false).

- "Two-sample" tests are used to compare two data sets (for example, site versus background data), rather than to compare two samples (as the name may imply). Samples of background groundwater will be collected to establish the local activities of radionuclides in groundwater at HPS. Standard two-sample statistical tests (for example, the t-test and the Wilcoxon Rank Sum test) will be used to conduct the site-to-background comparisons of radionuclides. H_o in this case must be that site groundwater contains levels of radionuclide activities that do not exceed background levels (that is, site activities are statistically indistinguishable from background). The goal is to test this hypothesis at 95 percent confidence level, with a minimum of 80 percent power.

Minimum detectable activities (MDA) reported by the laboratories will be compared with regulatory limits to ensure that analytical methods are sufficiently sensitive.

Step 7 – Optimize the Design for Obtaining Data

Groundwater sampling is limited to existing wells (at this point, no new wells will be installed for the data gaps sampling).

Two rounds of samples will be collected from 36 existing monitoring wells. Five of the 36 are background wells, and the remaining 31 wells are near areas where radioactively contaminated soil has been identified, in areas downgradient of buildings where radioactive materials were handled or stored, and in other areas to provide adequate spatial coverage across HPS. In addition, samples of sea water and potable water will be collected and analyzed for comparison purposes.

TABLE A-3

**IDENTIFICATION OF THE SEVEN STEPS OF THE DATA QUALITY OBJECTIVES PROCESS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA**

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Decision(s)**	**Identify Inputs to the Decision(s)**	**Define Study Boundaries**	**Develop Decision Rules**	**Specify Tolerable Limits on Error**	**Optimize Sampling Design**
Water Level Measurements						
Additional groundwater potentiometric surface maps are needed to assess the current conditions of groundwater flow in the A-aquifer, to evaluate seasonal effects, and to confirm the existence of anomalies identified on previous maps that may indicate broken or leaking utility lines.	Can groundwater potentiometric surface maps be constructed that are representative of the A-aquifer such that: 1. The general groundwater flow pattern can be identified, and 2. Preferential pathways for groundwater flow (sources or sinks) can be are identified?	Water levels will be measured at approximately 280 existing wells. Water level data will be used to define the current groundwater potentiometric surface using: • An appropriate numeric interpolation technique • Modification by a California-registered geologist • Underground utility line maps • TDS and salinity information for density correction	The areal limits for measurements of water levels consist of A-aquifer wells previously sampled at HPS. The vertical limit for measurements of water levels is the depth of the wells installed in the A-aquifer at HPS. The temporal limit of a single measurement event is a period that will begin 1 hour before a high or low tide and will not extend beyond 3 hours after the high or low tide. Subsequent water level measurements may be conducted to account for seasonal variations.	(1a) If the groundwater potentiometric surface map can be used to identify the general groundwater flow pattern, these data will be described in the GDGI report and used in the revised FSs to help evaluate groundwater flow and contaminant fate and transport. (1b) If the groundwater potentiometric surface map cannot be used to identify the general groundwater flow pattern based on professional judgment, new wells or piezometers will be installed and additional water level data will be collected to fill data gaps. (2a) If the interpretation of groundwater potentiometric surface maps indicates preferential contaminant flow to the Bay due to utility lines (such as groundwater mounds indicating water pipe leaks or groundwater sinks indicating groundwater entering the storm drain lines), utility lines will be identified for repair, if necessary. (2b) If the interpretation of groundwater potentiometric maps does not indicate preferential flow of contaminants to the Bay due to utility lines, further evaluation of utility lines is not required.	All decisions concerning the interpretation of hydrological data are judgmental and are based on the best professional judgment. Because all decisions are subjective, it is not possible to quantify the error rates. Possible errors include errors in water level measurements, which may lead to decision errors about the direction of groundwater flow. The water level measurements are required to be accurate to plus or minus 0.01 foot and are repeated three times.	Well locations are selected to provide general coverage across HPS, with a focus on individual RUs. Based on professional judgment and using numeric interpolation techniques, a California-registered geologist may identify areas where water level measurement data coverage is not sufficient to identify groundwater flow patterns with reasonable certainty. In locations where water level measurement data coverage is not sufficient, additional wells may be installed to assess groundwater potentiometric surface, as appropriate. Water level measurements will be collected during a period of relatively low tidal fluctuation in the Bay. The period of lowest fluctuation during a 28-day lunar cycle is best, but may not be convenient because the high and low tides may occur at night. A period of low fluctuation that allows water level measurement during daylight hours will be selected. The sampling design is described in further detail in the FSP.
B-Aquifer Study						
The extent of contamination in the B-aquifer and its relationship to contaminant plumes emanating from A-aquifer groundwater in Parcels C and E have not been evaluated because chemical and hydrogeologic data are insufficient to support an evaluation.	1. Do plumes of VOCs and other contaminants found in the A-aquifer extend into the B-aquifer, thereby indicating a hydraulic connection between the aquifers at that location?	• Samples of groundwater collected from existing B-aquifer wells and nested wells will be analyzed to provide validated chemical data. • Chemical data will be mapped in both plan and hydrogeological cross-section views to help illustrate the lateral extent of contamination and potential migration pathways in the B-aquifer.	The areal limits of the B-aquifer study area are the boundaries of the A-aquifer groundwater AOCs in Parcels C and E. The vertical limit of the B-aquifer study area is a depth of 5 feet below the bottom of the B-aquifer or to the bottom of VOC or other contamination, whichever is less. The temporal limit of the B-aquifer study is approximately 2 months (when the wells will be sampled once). Additional phases of the B-aquifer study may be conducted to account for seasonal variations.	(1a) If chemical data indicate that contamination in the A-aquifer has migrated to the B-aquifer and is not adequately characterized, additional sampling locations will be proposed to characterize the vertical and areal extent of the plume in the B-aquifer and the conceptual model will be updated. (1b) If chemical data indicate that the B-aquifer in the area does not contain chemicals at concentrations that exceed the most stringent primary MCL or HGAL (or aquatic criterion, as applicable), characterization of contamination in the B-aquifer will be considered complete.	MQOs in the form of precision and accuracy goals (Section A5.5) are designed to minimize analytical errors. Chemical data will be quantitatively evaluated; however, the sampling design is judgmental rather than probabilistic, so tolerable limits on decision errors cannot be rigorously quantified.	Groundwater samples will be collected from B-aquifer wells in Parcels C and E. These samples will be the second round collected for these wells. Two rounds of groundwater data have been collected in B-aquifer wells at Parcel D, and these wells will not be resampled in the Phase III GDGI.

TABLE A-3 (Continued)

IDENTIFICATION OF THE SEVEN STEPS OF THE DATA QUALITY OBJECTIVES PROCESS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Decision(s)**	**Identify Inputs to the Decision(s)**	**Define Study Boundaries**	**Develop Decision Rules**	**Specify Tolerable Limits on Error**	**Optimize Sampling Design**
A-Aquifer and Bedrock Water-Bearing Zones						
Groundwater AOCs in the A-aquifer and bedrock water-bearing zones were identified based on data collected more than 4 years ago and may not reflect current conditions.	1. Is the lateral extent of the contaminant groundwater plumes in the A-aquifer AOCs adequately characterized based on current conditions? 2. Do the contaminant plumes extend into the bedrock water-bearing zones at any location, thereby indicating a hydraulic connection at that location?	• Current chemical data (with detection limits below potential ARARs) for analytes of potential concern in groundwater collected from existing wells screened in the existing A-aquifer and bedrock water-bearing zones. • Chemical data mapped in both plan and hydrogeological cross-section views (to help illustrate the lateral extent of contamination and potential migration pathways to the bedrock water-bearing zone.) • Previously collected chemical data for groundwater.	The areal limit of the study of the A-aquifer and bedrock water-bearing zones is the lateral extent of the contaminant plumes that emanate from A-aquifer groundwater at Parcels C and E. The vertical limit of the study of the A-aquifer and bedrock water-bearing zones is the thickness of the A-aquifer and the depth of the bedrock wells or to the bottom of the contamination, whichever is less. The temporal limit of the study of the A-aquifer and bedrock zones is 2 months (when the wells will be sampled once). Additional phases of this study may be conducted to account for seasonal variations.	(1a) If chemical data indicate that the horizontal extent of contamination in the A-aquifer is not adequately characterized for current conditions, additional sampling locations will be proposed to improve the characterization of the horizontal extent of contaminant plumes in the A-aquifer and to update the conceptual model. (1b) If chemical data indicate that the horizontal extent of contamination in the A-aquifer is adequately characterized, horizontal characterization of contamination in the A-aquifer will be considered complete. (2a) If the chemical data indicate that contamination has migrated from the A-aquifer to the bedrock water-bearing zones, additional sampling locations will be proposed to characterize the horizontal and vertical extent of the plume in the bedrock water-bearing zone and the conceptual model will be updated. (2b) If the chemical data indicate that contamination has not migrated from the A-aquifer to the bedrock water-bearing zones, characterization of contamination in the bedrock water-bearing zones will be considered complete.	MQOs in the form of precision and accuracy goals (Section A5.5) are designed to minimize analytical errors. Chemical data will be quantitatively evaluated; however, the sampling design is judgmental rather than probabilistic, so tolerable limits on decision errors cannot be rigorously quantified.	A-aquifer wells and bedrock water-bearing zone wells have been sampled for two rounds in Parcels C and D and one round in Parcel E. For the Phase III GDGI, A-aquifer wells will be sampled throughout Parcels C and E and in IR-22 in Parcel D. Bedrock water-bearing zone wells will be sampled in Parcels C and E. Data for additional parameters may be collected to support remedial decisions and to evaluate technologies in the FS. The following criteria will be used to select wells for additional sampling: • Wells within RUs identified previously (based on ecological risk and human health risk via the inhalation exposure pathway) will be selected for resampling. • Certain wells surrounding previously identified RUs will be selected for resampling if historical data indicate chemicals are present at concentrations that exceed MCLs, HGALs, or aquatic criteria. • Certain wells with isolated detections of chemicals at concentrations that exceed MCLs, HGALs, or aquatic criteria will be selected for resampling. Some wells surrounding RUs identified previously will be selected for resampling even if their historical data do not indicate the presence of analytes at concentrations that exceed MCLs, HGALs, or aquatic criteria. These wells will be selected to evaluate (1) the extent of the current RUs and (2) the potential for plume migration.

TABLE A-3 (Continued)

IDENTIFICATION OF THE SEVEN STEPS OF THE DATA QUALITY OBJECTIVES PROCESS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Decision(s)**	**Identify Inputs to the Decision(s)**	**Define Study Boundaries**	**Develop Decision Rules**	**Specify Tolerable Limits on Error**	**Optimize Sampling Design**
Hydraulic Tests						
In AOCs in Parcels C and E, the following aquifer hydraulic characteristics are not sufficiently understood: • Hydraulic connection between the A-aquifer and B-aquifer or bedrock water-bearing zones • Aquifer transmissivity and storativity • Potential well yield	1. Is there a significant hydraulic connection between the A-aquifer and B-aquifer or bedrock water-bearing zone based on professional judgment using data from pumping tests? If a connection exists, what is the nature of the connection? 2. Does the potential well yield exceed the federal criterion for beneficial use as a drinking water supply?	• Water levels measured in pumping and observation wells during pumping tests • Values of aquifer parameters (leakance, transmissivity, storativity, and hydraulic conductivity) calculated using pumping test data • Water levels measured in pumping and observation wells during step-drawdown tests • Values of potential well yield calculated using data from step-drawdown and constant-rate tests	Hydraulic testing will target the AOCs in Parcels C and E. The vertical limits of hydraulic testing are the B-aquifer zone or shallow bedrock. The temporal limit for hydraulic testing is 2 months.	(1a) If there is a significant hydraulic connection between the A-aquifer and B-aquifer or bedrock water-bearing zones, further investigation will be considered to define the potential impacts of A-aquifer contamination on groundwater in the B-aquifer and bedrock water-bearing zones. (1b) If there is not a significant hydraulic connection between the A-aquifer and B-aquifer or bedrock water-bearing zones, no further investigation is necessary to define the potential impacts of A-aquifer contamination on groundwater in the B-aquifer zone groundwater. (1c) If the evaluation of the test data yields inconclusive results about the possible hydraulic connection between the A- and B-aquifers, additional aquifer testing may be conducted. (2a) If step-drawdown and constant-rate tests results show that the long-term potential well yield of an aquifer zone equals or exceeds the federal criterion for beneficial use of groundwater, that aquifer zone will be considered to have sufficient potential yield for a residential drinking water supply based on the federal beneficial use criterion. (2b) If step-drawdown test results show that the potential well yield of an aquifer zone does not exceed the federal criterion for beneficial use of groundwater, that aquifer zone will be considered to have insufficient potential yield for a residential drinking water supply based on the federal beneficial use criterion.	Because decisions on aquifer hydraulic connection will be made using professional judgment, tolerable limits on decision errors cannot be quantified. The accuracy of water level measurement instruments and measuring point elevation surveys should be plus or minus 0.01 foot.	Wells for the pumping tests will be selected based on the following criteria: • Location in areas of known A-aquifer contamination • High yield • Screened in permeable zone Water levels in A- and B-aquifer and bedrock water-bearing zone wells will be monitored during the tests. These wells will be selected based on proximity to the A-aquifer pumping wells. Data from the step-drawdown tests data will be plotted in the field, and step changes will be made at the direction of the supervising hydrogeologist. The data from the step-drawdown tests will be interpolated to determine (1) the optimum pumping rate for 72-hour constant rate pumping tests to be conducted at each pumping well and (2) the potential well yield. Data from the constant-rate pumping tests data will also be plotted in the field. The test may be terminated at the direction of the supervising hydrogeologist; at which time, collection of recovery data will begin.

TABLE A-3 (Continued)

IDENTIFICATION OF THE SEVEN STEPS OF THE DATA QUALITY OBJECTIVES PROCESS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Decision(s)**	**Identify Inputs to the Decision(s)**	**Define Study Boundaries**	**Develop Decision Rules**	**Specify Tolerable Limits on Error**	**Optimize Sampling Design**
Preferential Flow and Tidal Studies						
The preferential flow patterns in shallow groundwater near the shoreline at HPS are not well understood and may be masked by tidal influence. This understanding is needed to evaluate contaminant migration pathways from groundwater AOCs to the Bay. The extent of the TMZ is not defined and may be helpful in defining the POC.	1. Can preferential pathways of groundwater flow be identified after filtering out the tidal influence in shallow groundwater at HPS? 2. Do selected wells within the TIZ experience tidal mixing, as measured by changes in the electrical conductivity of groundwater in those wells? (This is an optional investigation that will only be conducted if deemed necessary to help identify the POC.)	• Continuous water level data from existing shallow monitoring wells and piezometers and newly installed piezometers in areas of potential tidal influence. (These data will be used to determine the mean groundwater elevations at each of the wells measured.) • Continuous water elevation data from a surface water station in the Bay. (These data will be used to determine the mean surface water elevation in the Bay.) • The flow path for groundwater will be determined from mean elevations of groundwater. • Tidal efficiencies and time lags will also be determined from the elevation data that will be continuously collected for surface water and groundwater, as described above. (The tidal efficiencies and time lags will allow the calculation of future mean groundwater elevations using single water level measurements.) • Continuous data for electrical conductivity in groundwater from selected shallow monitoring wells within the TIZ. (This is an optional investigation that will only be conducted if deemed necessary to help identify the POC.)	The areal limit of the tidal studies extends from the Bay shoreline to approximately 400 feet inland, within the boundaries of Parcels B, C, D, and E. The station for measurement of surface water elevations in the Bay will be located near Building 253, which is in Parcel C. The vertical limit of the tidal studies is constrained to the cumulative thickness of the A-aquifer, B-aquifer, and bedrock water-bearing zones. The temporal limit of the tidal studies is approximately 2 months. The temporal limit for the tidal study at a specific AOC is 7 days.	(1a) If, based on professional judgment, data for the mean elevation of groundwater (that is, with tidal effects filtered out) indicate that groundwater flowing from an AOC is affected or influenced by a storm drain or sewer line, the fate and transport evaluation will use the flow path from the AOC to the storm-drain line as the effective travel distance for contaminant migration from the AOC to the Bay. In addition, utility lines will be identified for repair, if necessary, and new water level measurements will be conducted. (1b) If, based on professional judgment, data for the mean elevation of groundwater indicate that groundwater flowing from an area of concern is not intercepted by a storm sewer drain line, the fate and transport evaluation will use the flow path from the AOC to the Bay as the travel distance for contaminant migration and further evaluation of utility lines in that area will be considered complete. (2a) If, based on professional judgment, electrical conductivity values for a particular well fluctuate with a pattern that correlates with the tide, that well will be considered to be within the TMZ. (2b) If, based on professional judgment, electrical conductivity values for a particular well do not fluctuate with a pattern that correlates with the tide, that well will be considered to be outside of the TMZ.	Because decisions on tidal mixing and near-shore flow patterns will be made using professional judgment, tolerable limits on decision errors cannot be quantified. The accuracy of water level measurement instruments and measuring point elevation surveys is usually plus or minus 0.01 foot. The accuracy of electrical conductivity measurement instruments is plus or minus 0.05 percent.	Wells and piezometers to be monitored for tidal influence and tidal mixing will be selected based on the following criteria: • Located within the TIZ • Located near groundwater sinks and mounds • Located near storm sewer lines that are below the water table Groundwater levels will be measured at 15-minute intervals for 7 to 10 days. Surface water levels will be measured at 15-minute intervals for the duration of the tidal studies. Electrical conductivity will be measured at 1-hour intervals for 7 to 10 days. (This is an optional investigation that will only be conducted if deemed necessary to help identify the POC.)

TABLE A-3 (Continued)

IDENTIFICATION OF THE SEVEN STEPS OF THE DATA QUALITY OBJECTIVES PROCESS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
State the Problem	**Identify the Decision(s)**	**Identify Inputs to the Decision(s)**	**Define Study Boundaries**	**Develop Decision Rules**	**Specify Tolerable Limits on Error**	**Optimize Sampling Design**
Radiological Data Gaps Study						
Areas of radioactively contaminated soils have been identified and removed from HPS; however, existing data for radionuclides and radiogenic indicator parameters (gross alpha and gross beta) in samples of sitewide groundwater and soil and groundwater collected in Parcel E do not provide sufficient coverage and specificity to make defensible remedial decisions for groundwater. Data are also limited for local background activities of specific radioisotopes. Isotope-specific data for groundwater are needed to evaluate whether site-related radioactive contamination occurs in groundwater at HPS, and if so, to delineate the extent of the groundwater contamination.	1. Do the levels of radionuclide species in groundwater from Parcel E or elsewhere at HPS exceed regulatory limits? 2. Do the activities of radionuclide species in groundwater from background areas (including sea water) exceed regulatory limits? 3. Has groundwater in areas of radioactively contaminated soils been affected by site-related radionuclides that leached from soils and into shallow groundwater, such that activities are significantly above background levels? 4. Are high activities of gross beta reported in the existing data set the result of naturally occurring K-40 derived from sea water (K-40 mean equals 300 pCi/L) or are the beta activities the result of site-related radionuclides?	• New and existing analytical data (validated and defensible) for specific radionuclides in samples of shallow groundwater collected from wells near areas of radioactively contaminated soils and from background areas within and outside of HPS, including sea water. • Historical documentation and personnel knowledge on the handling, treatment, and storage of radioactive materials at HPS. • Supporting data for groundwater samples, including TSS, TDS, pH, and conductivity. • Background data reported in the literature for radionuclides and radiological indicators. • Hydrogeologic information, including water level, gradient, seasonal fluctuations, and directions of flow. • Information on well construction, depth of screened intervals, and well production volumes. • Regulatory screening levels or potential ARARs for radionuclides. • Knowledge of the geochemical behavior of various radioactive elements.	The lateral boundary of the study area includes wells throughout HPS and off-site areas for additional background samples. The vertical boundary of the study extends from ground surface and into shallow groundwater. The temporal boundary of the study is constrained by the period of performance, which is estimated to be 5 months.	(1a) If levels of radionuclides in site groundwater samples exceed regulatory limits, site data will be compared with background data. (1b) If levels of radionuclides in site groundwater samples do not exceed regulatory limits, the groundwater will not be further evaluated. (2a) If background radioactivity exceeds regulatory limits, realistic cleanup goals for radioactivity in groundwater at HPS will be established, so the Navy is not held to cleanup to levels below background. (2b) If background radioactivity does not exceed regulatory limits, standard site-to-background statistical comparisons will be performed to evaluate whether site radioactivity exceeds background levels. (3a) If analytical data show statistically significant differences in the activities of radionuclides in site and background groundwater, site groundwater in the area will be further evaluated and further remedial action may be recommended. (3b) If analytical data show statistically indistinguishable activities of radionuclides in site and background groundwater, site groundwater in the area will be considered not contaminated and further remedial action will not be recommended. (4a) If gross beta activity correlates strongly with naturally occurring activities of K-40 in sea water, gross beta will not be used as an indicator for site-related effects. Rather, isotope-specific analyses are needed to distinguish the natural or site-related source of beta activity in site groundwater. (4b) If gross beta activity shows no correlation with naturally occurring activities of K-40, gross beta may be used as an indicator for site-related effects to site groundwater.	MQOs will be established for sample analysis, and the analytical data will undergo QA/QC review to ensure that MQOs are met. Appropriate parametric or nonparametric one-sample or two-samples tests will be used to compare radionuclide activities with cleanup levels or with a background population that has a goal of 95 percent level of confidence (that is, the null hypothesis that the site data exceed regulatory limits [one-sample tests] or that data sets are taken from the same population [two-sample tests] will be rejected if the p-value for the statistical test is less than 0.05). Minimum detectable activities reported by the laboratories will be compared with regulatory limits to make certain that analytical methods are sufficiently sensitive.	Groundwater sampling is limited to existing wells (at this point, no new wells will be installed for the data gaps sampling). Two rounds of samples will be collected from 36 existing monitoring wells. Five of the 36 wells are background wells, and the remaining 31 wells are near areas where radioactively contaminated soils have been identified, in areas downgradient of buildings where radioactive materials were handled or stored, and in other areas to provide adequate spatial coverage across HPS. In addition, samples of sea water and potable water will be collected and analyzed for comparison purposes.

Notes:

ARAR	Applicable or relevant and appropriate requirement
AOC	Area of concern
Bay	San Francisco Bay
FSP	Field sampling plan
GDGI	Groundwater data gaps investigation
HGAL	Hunters Point groundwater ambient level
HPS	Hunters Point Shipyard
IR	Installation Restoration
K-40	Potassium-40
MCL	Maximum contaminant level
MQO	Measurement quality objective
Navy	U.S. Department of the Navy
pCi/L	Picocuries per liter
QA/QC	Quality assurance and quality control
POC	Point of compliance
RU	Remedial unit
TDS	Total dissolved solids
TIZ	Tidal influence zone
TMZ	Tidal mixing zone
TSS	Total suspended solids
VOC	Volatile organic compound

A2 PROJECT AND TASK ORGANIZATION

This section discusses management of the Phase III GDGI. A well-organized project team, combined with adequate experience and proper training, will promote consistent quality throughout the investigation. Sections A2.1 and A2.2 present the task organization for the project, including the specific roles and responsibilities of project participants. Section A2.3 discusses training requirements for project members, and Section A2.4 identifies the schedule for the work to be conducted.

A2.1 PROJECT ORGANIZATION AND PERSONNEL

The following personnel are involved in Phase III GDGI field efforts. In some cases, more than one responsibility has been assigned to a single individual. Figure A-1 shows an organization flowchart.

Name	Responsibility	Location	Telephone
David DeMars	Navy Lead Remedial Project Manager	Naval Facilities Engineering Command, San Diego, California	(619) 532-0912
Narciso Ancog	Navy QA Officer	Naval Facilities Engineering Command, San Diego, California	(619) 532-2540
Keith Forman	BRAC Environmental Coordinator	Naval Facilities Engineering Command, San Diego, California	(619) 532-0786
Daniel Chow	Program Manager	TtEMI, San Francisco, California	(415) 222-8222
Mike Wanta	Installation Coordinator	TtEMI, San Francisco, California	(415) 222-8241
Tong Li	Project Manager	TtEMI, Seattle, Washington	(425) 673-3664
Greg Swanson	Program QA Manager	TtEMI, San Diego, California	(619) 718-9676
Ron Ohta	Project QA Manager	TtEMI, Sacramento, California	(916) 853-4506
Greg Mason	On-site Quality Assurance Officer	TtEMI, San Francisco, California	(415) 222-8270
Jim Romine	Program Health and Safety Manager	TtEMI, Cincinnati, Ohio	(513) 564-8351
William Warren	Project Health and Safety Coordinator	TtEMI, San Francisco, California	(415) 222-8293
Robert O'Brien	Project Health Physicist	TtEMI, San Francisco, California	(415) 222-8252
Rob Morrow	On-site Health and Safety Officer	TtEMI, San Francisco, California	(415) 222-8262
Nadia Borisova	Project Chemist	TtEMI, San Francisco, California	(415) 222-8275
Hwakong Cheng	Field Team Leader	TtEMI, San Francisco, California	(415) 222-8340
Kimberly Tom	Database Manager	TtEMI, San Francisco, California	(415) 222-8272
Susan Gallagher	Sample Tracking Coordinator	TtEMI, San Francisco, California	(415) 222-8329

A2.2 PROJECT TEAM RESPONSIBILITIES

No change.

A2.3 SPECIAL TRAINING AND CERTIFICATION

No change.

A2.4 PROJECT SCHEDULE

Table 8-1 of the accompanying FSP addendum presents the implementation schedule for sampling and analysis and the associated reporting. Field sampling for radionuclides will be conducted in two events, with at least 3 months between sampling events.

A3 SITE BACKGROUND AND PROBLEM DEFINITION

As detailed in Section A1.3.3, the following six tasks will be conducted as part of the Phase III GDGI:

- Measure basewide water levels to calculate the piezometric surface at existing A-and B-aquifer wells
- Further characterize the B-aquifer in Parcels C and E by sampling existing and newly installed wells for analysis of hydrogeologic and chemical parameters
- Resample existing A-aquifer and bedrock water-bearing zone wells in Parcels C, D, and E to characterize the extent of contamination
- Carry out hydraulic testing to evaluate hydraulic characteristics and parameters of the shallow aquifer system in Parcels C and E
- Evaluate tidal influences on the direction of flow and potentially the composition of near-shore groundwater at HPS in Parcels C, D, and E
- Conduct radiological assessment of isotopic composition of groundwater by sampling selected wells and analyzing the samples for a suite of isotope species

Most of the existing groundwater monitoring wells at HPS were installed during the RI, which was conducted between 1990 and 1995. Wells will be installed and developed in the future under the Phase III GDGI in a manner consistent with procedures specified in TtEMI standard operating procedure (SOP) No. 020, “Monitoring Well Installation,” and No. 021, Revision 3, “Monitoring Well Development” (see Appendix C of the FSP addendum). Methods of groundwater sampling will be consistent with the procedures presented in TtEMI SOPs No. 010 and 015 (see Appendix C of the FSP addendum). Static groundwater levels will be measured in selected wells throughout HPS, as specified in the FSP addendum.

Complete background information, such as geologic data on the Bay area and HPS and information about HPS and site-specific operational histories, environmental restoration, and the results of environmental investigation and analysis, is presented in the RI reports (PRC 1996a, 1996b, 1997a, 1997b) and the FS reports (PRC 1996c, 1997c; TtEMI 1998a, 1998b).

The following sections summarize site backgrounds and describe the purpose of the Phase III GDGI at Parcels C, D, and E. Table 4-3 of the accompanying FSP addendum summarizes the data collection requirements, including the proposed analytical suite.

A3.1 PARCEL C

Areas of Parcel C areas where groundwater is significantly contaminated are located in IR-25 and IR-28. A brief background of each IR site and a general description of the purpose of the current investigation at Parcel C are presented below.

A3.1.1 Background

No change.

A3.1.2 Purpose of the Current Investigation

The purpose of the current investigation is to characterize existing data gaps in IR-25 and IR-28 as follows:

- Collect water level measurements from existing and newly installed A- and B-aquifer wells to calculate horizontal and vertical gradients
- Collect updated chemical data from existing and newly installed B-aquifer wells to characterize the vertical extent of contamination on the basis of the drinking water pathway, particularly in areas where no Bay Mud aquitard separates the shallow A-aquifer from the underlying B-aquifer (RU-C1, RU-C2, RU-C4, RU-C5, and RU-C7)
- Collect updated chemical data from existing A-aquifer and bedrock water-bearing zone monitoring wells to confirm the horizontal extent of RUs, which are based on drinking water standards

- Conduct hydraulic tests to evaluate the hydraulic characteristics of the shallow aquifer system; calculate hydraulic parameters for the A-aquifer zone; evaluate hydraulic communication among the A-aquifer, B-aquifer, and bedrock water-bearing zones; obtain detailed hydrogeologic interpretations for treatability studies at RUs; and refine the hydrogeologic conceptual models for Parcel C and local RUs

- Conduct tidal studies to evaluate the extent of tidal influence, analyze patterns of groundwater flow, quantify tidal influence parameters, and potentially characterize the TMZ in IR-28 and IR-29

- Collect two rounds of groundwater samples from one well in Parcel C as part of the basewide data gaps study of radionuclides in shallow groundwater

A3.1.3 Hydrogeological Conceptual Model

A preliminary hydrogeological conceptual model for Parcel C was presented in the Parcel C information package for the Phase II GDGI (TtEMI 2001d). The model is based on the conclusions of the Parcel C RI report and on an evaluation of groundwater quality data from the Phase I and Phase II GDGIs. The results of the Phase III GDGI will be used to refine the hydrogeological conceptual model. Hydrogeological data will be combined with data on characteristics of the contaminant source and groundwater quality to identify and screen remedial technologies that are applicable to general response actions to address analytes of concern in Parcel C.

Hydrostratigraphy and Lithology

The stratigraphy at Parcel C, generalized from basewide conditions, occurs in the following sequence from top to bottom: artificial fill, undifferentiated upper sand, Bay Mud, undifferentiated sediments, and bedrock. In general, northwestern Parcel C is underlain by a few feet of artificial fill over shallow bedrock. Depth to bedrock increases to the southeast from IR-58 toward Berth 2, as does the thickness of the artificial fill. Wedges of the undifferentiated upper sands, Bay Mud, and undifferentiated sediments lie between the fill material and bedrock in southeastern Parcel C.

According to the RI, two aquifers and one water-bearing zone occur at Parcel C: the unconfined A-aquifer, a deeper semiconfined or confined B-aquifer, and the bedrock water-bearing zone. An aquitard of finer-grained material lies between the A- and B-aquifers.

The A-aquifer is primarily composed of the extremely heterogeneous artificial fill material and, in some places, coarse-grained materials of the undifferentiated upper sands. Groundwater levels measured in A-aquifer wells in February 2001 range from 0.31 foot below to 4.32 feet above mean sea level (msl).

The A-aquifer is in direct contact with bedrock where artificial fill directly overlies bedrock and fine-grained material is absent.

The B-aquifer is primarily composed of coarser-grained material of the undifferentiated sediments unit, confined to semiconfined by the fine-grained aquitard. Groundwater levels measured in 10 B-aquifer wells in February 2001 ranged from 1.00 foot below to plus 2.93 feet above msl. The B-aquifer is likely discontinuous across Parcel C.

Groundwater of the bedrock water-bearing zone described in the Parcel C RI as not fully characterized is limited to discrete fractures and shear zones that are susceptible to groundwater infiltration. Groundwater levels measured in 10 bedrock water-bearing zone wells in February 2001 ranged from plus 1.31 feet below to 3.10 above msl. Recharge, although again not fully characterized, may be attributable to precipitation runoff and potential hydraulic connections with both the A- and B-aquifers.

Groundwater Flow Patterns

In general, groundwater flows to the southeast at Parcel C, but isolated groundwater mounds and sinks cause local variations in the direction of flow. Potential causes for localized variations in the patterns of groundwater flow at Parcel C include extreme heterogeneity of the aquifer zones and barriers and conduits caused by building foundations and utility corridors. Groundwater potentiometric surfaces from historical measurement events generally agree with the pattern from the February 2001 measurement event; they all indicate groundwater flow to the southeast toward Berths 1 through 4 and a steep northeastward gradient in the area southwest of Building 134. A localized groundwater trough appears south of Building 134, suggesting potential effects from subsurface utilities. In general, the groundwater potentiometric surfaces are highest in western and northwestern Parcel C, with groundwater flow toward the dry docks and berths.

Tidal influence was qualitatively evaluated in 15 A-aquifer wells and in 3 wells screened in bedrock along the shoreline of Parcel C by measuring water levels at various times during a tidal cycle. A significant tidal influence, defined as water level fluctuations that exceeded 0.1 foot during the measurement period, was observed in at least 12 of the 18 wells. A more detailed study of tidal influence is to be conducted during the Phase III GDGI.

Potential communication between aquifer zones is affected by the sequence of the individual water-bearing units at Parcel C. Where the Bay Mud and low permeability artificial fill and natural sediment separate the A-aquifer from the B-aquifer, groundwater may migrate vertically between the two zones. However, vertical migration is probably impeded by the low hydraulic conductivity of the aquitard. Where the A-aquifer directly overlies the zone of fractured bedrock, it is possible that groundwater could migrate both horizontally and vertically from the A-aquifer to the fractured bedrock zone. The hydraulic connection between the A- and B-aquifers will be further evaluated using the results of the hydraulic tests during the Phase III GDGI.

A3.1.4 Remedial Units

This section provides additional hydrogeological and chemical information on the following RUs at Parcel C: RU-C1 (Buildings 211, 231, and 253), RU-C2 (north of Building 251), RU-C4 and RU-C7 (Buildings 271, 272, 258, and 281), and RU-C5 (Building 134) (Figure 4-2 of the accompanying FSP addendum). Analytes of concern at these RUs include tetrachloroethene (PCE), trichloroethene (TCE), and degradation products; other VOCs such as benzene; SVOCs; PCBs; pesticides; and metals. The Phase III GDGI sampling program consists of 51 A-aquifer, 16 B-aquifer, and 19 bedrock monitoring wells situated in and around the RUs. Based on a review of historical data and the results of the Phase II GDGI, the Navy believes that the current sampling plan adequately addresses the data needs at Parcel C.

RU-C1

The A-aquifer at RU-C1 consists of about 30 feet of artificial fill and 10 to 25 feet of undifferentiated upper sands. A layer of Bay Mud is present at about 10 to 55 feet below ground surface (bgs), separating the A-aquifer from deeper hydrogeological regions. The B-aquifer is discontinuous across RU-C1 but is as thick as 10 feet in some areas. Top of bedrock occurs at depths of 25 to 70 feet bgs. The upper 10 to 15 feet of bedrock at RU-C1 is considered the weathered zone because it consists of less competent bedrock.

Thirty-six monitoring wells are located within RU-C1. They include 31 wells screened in the A-aquifer (ranging from 5 to 32.5 feet bgs), 4 wells screened in the B-aquifer (ranging from 20 to 60.8 feet bgs), and 1 well screened in bedrock (40 to 55.5 feet bgs). Downward vertical gradients have been observed at well pair IR28MW170A/IR28MW400B, just south of RU-C1, and at well pair IR28MW339A/ IR28MW399B, located within RU-C1. Well pair IR28MW136A/IR28MW314B showed an insignificant vertical gradient.

Plumes of PCE; TCE; and trans-1,2-dichloroethene (-DCE) are collocated in three separate plumes in the following areas: (1) northwestern portion of Building 231, (2) south-central portion of Building 231, and (3) northeastern corner of Building 253. The plume of TCE is the largest, covering 95,000 square feet in the northwestern portion of Building 231, 32,000 square feet in the south-central portion of Building 231, and 35,000 square feet in the northeastern portion of Building 253. However, concentrations of chlorinated solvents are relatively low; the maximum detected concentration of TCE in RU-C1 was 700 micrograms per liter (µg/L) in a sample collected in December 1995.

Plumes of cis-1,2-DCE; vinyl chloride; and benzene are discontinuous but overlap the plumes of PCE; TCE; and trans-1,2-DCE. Additional analytes of potential concern include other VOCs (1,4-dichlorobenzene [-DCB]; 1,1-dichloroethane; ethylbenzene; and methylene chloride); SVOCs (bis[2-ethylhexyl]phthalate and 2-chloronapththalene); one PCB (Aroclor-1260); one pesticide (4,4'-dichlorodiphenyltrichloroethane [-DDT]); and metals.

Concentrations that exceed evaluation criteria were primarily detected in samples from wells screened in the A-aquifer at depths ranging from 5 to 20 feet bgs. Samples from monitoring well IR28MW314B screened in the B-aquifer contained elevated levels of cis-1,2-DCE; trans-1,2-DCE; vinyl chloride; and benzene. The Phase III GDGI sampling program consists of 10 A-aquifer and 4 B-aquifer monitoring wells located within RU-C1. In addition, 10 monitoring wells located outside of RU-C1 will be sampled.

RU-C2

The A-aquifer at RU-C2 consists of approximately 5 to 10 feet of artificial fill that overlies 10 to 35 feet of native sediment. Interlayered Bay Mud and undifferentiated units lie on top of bedrock, which varies in depth from 30 to 70 feet bgs. As a result of the relatively high relief of bedrock in this small area and the interlayered nature of the Bay Mud unit with undifferentiated units, bedrock is sometimes in direct contact with both the A- and B-aquifers. The B-aquifer zone is discontinuous at RU-C2 and is more prevalent in the western and southeastern portions of RU-C2, where bedrock is deeper. Bedrock is shallowest in the central portion of this RU.

RU-C2 contains nine monitoring wells, including seven wells screened in the A-aquifer (ranging from 5 to 25 feet bgs) and two wells screened in the B-aquifer (ranging from 9.5 to 25 feet bgs). An upward vertical gradient was observed in well pair IR28MW397A/IR28MW397B at the southeastern edge of RU-C2.

Plumes of PCE; TCE; cis-1,2-DCE; and vinyl chloride are centered around the northern portion of Building 251. Concentrations that exceed evaluation criteria for groundwater were detected in samples from one A-aquifer monitoring well (screened from 5 to 15.5 feet bgs) and two B-aquifer monitoring wells (screened intervals ranging from 9.5 to 25 feet bgs). Concentrations of PCE and TCE at RU-C2 are relatively low, with maximum detections of 28 μg/L for PCE and 40 μg/L for TCE. Cis-1,2-DCE was detected at a maximum concentration of 3,600 μg/L in samples collected at well IR58MW31A. Other VOCs such as benzene; carbon tetrachloride; chlorobenzene; 1,2-DCB; and 1,4-DCB were detected in samples collected at these monitoring wells. PCBs (Aroclor-1260), pesticides (4,4'-DDT; dieldrin; endrin; and heptachlor epoxide), and metals have also been detected in samples from these wells, although most elevated concentrations were isolated.

Contamination at RU-C2 affects both the A- and B-aquifers. One A-aquifer and two B-aquifer monitoring wells will be sampled during the Phase III GDGI. Sampling will include eight additional wells located outside RU-C2.

RU-C4 and RU-C7

RU-C4, RU-C7, and western Parcel C are areas of relatively shallow bedrock. The top of bedrock at RU-C4 ranges from depths of 5 to 25 feet bgs and has an undulating surface. Bedrock across central RU-C7 is at 5 feet bgs and is relatively flat. Depth to bedrock increases to the east, up to 25 feet bgs. The thickness of artificial fill at RU-C4 and RU-C7 ranges from 5 to 20 feet, and artificial fill commonly lies directly above bedrock, placing the shallow bedrock water-bearing zones in contact with the A-aquifer.

Three A-aquifer monitoring wells screened from 4 to 19 feet bgs are located in RU-C4. In addition, 27 wells are screened in bedrock, with screened intervals ranging from 5.5 to 59.3 feet bgs. A downward vertical gradient was observed in well pair IR28MW311A/IR28MW310F.

Collocated plumes of TCE, PCE, their degradation products, and carbon tetrachloride are centered near the sump and dip tanks area in the southwestern corner of Building 281. The plume of TCE is the largest, covering approximately 200,000 square feet. TCE was detected at 62,000 μg/L in August 2000 in a sample collected at monitoring well IR28MW211F located at the center of the plume. Dense nonaqueous-phase liquid (DNAPL) may be present based on the high concentrations of TCE in groundwater samples at RU-C4. Additional analytes of concern include other VOCs, SVOCs, and metals. Concentrations that exceed evaluation criteria were detected in samples from monitoring wells screened in both the A-aquifer and in bedrock, with screened intervals ranging from 4 to 36 feet bgs.

RU-C7 encompasses RU-C4 but extends farther north. The hydrogeology at RU-C7 is similar to RU-C4. Five additional bedrock monitoring wells are located within RU-C7 but outside of RU-C4. A plume of carbon tetrachloride is located just north of RU-C4, within RU-C7.

Most contamination at RU-C4 is in the A-aquifer and shallow bedrock zone. The Phase III GDGI will include sampling of three A-aquifer and seven bedrock monitoring wells located in RU-C4. In addition, sampling will include four bedrock monitoring wells located outside RU-C4 but within RU-C7. Approximately 13 wells surrounding RU-C4 and RU-C7 will also be sampled.

RU-C5

Artificial fill at RU-C5 ranges in thickness from 15 to 30 feet bgs, with its thicker sections in the northern portion of RU-C5. The fill is underlain directly by 3 to 10 feet of interlayered undifferentiated upper sands and Bay Mud. Below the upper sands and the Bay Mud are undifferentiated sediments, which occur in thicknesses from 3 to 8 feet and are thicker at northern RU-C5, where bedrock is deeper. B-aquifer zones occur at RU-C5 in sandy units resting directly on bedrock. Fourteen A-aquifer and eight B-aquifer monitoring wells are located within RU-C5. A-aquifer wells were screened from 4 to 30 feet bgs, and B-aquifer wells were screened from 10.6 to 29 feet bgs. Groundwater data from well pair IR25MW15A1/IR25MW15A2 indicate downward migration of the chlorinated solvents.

Plumes of PCE, TCE, and their degradation products in shallow groundwater are centered at the western portion of Building 134 around monitoring wells IR25MW19A, IR25MW15A1/A2, and IR25MW18A. The plume of PCE is the largest, covering about 13,000 square feet, with a maximum concentration of 72,000 µg/L (IR25MW19A). Temporal data show that the plumes are not expanding or migrating horizontally. DNAPL may be present based on the high concentrations of PCE and TCE in groundwater samples. Additional analytes of potential concern include other VOCs, SVOCs, one PCB (Aroclor-1260), pesticides, and metals. Elevated levels of these analytes were detected in samples from A-aquifer monitoring wells screened from 3.5 to 30 feet bgs.

Contamination at RU-C5 is primarily contained within the A-aquifer. The Phase III GDGI sampling program at RU-C5 consists of 17 A-aquifer and 3 B-aquifer monitoring wells covering an area of 85,000 square feet. These monitoring wells are situated in and around the groundwater plumes.

A3.2 PARCEL D

The RI and FS reports for Parcel D (PRC 1996b, 1997c) stated that groundwater at Parcel D does not pose an unacceptable risk to human health (through the inhalation pathway) or an unacceptable ecological risk to aquatic receptors. A brief background of each IR site and a general description of the purpose of the current investigation at Parcel D are presented below.

A3.2.1 Background

No change.

A3.2.2 Purpose of the Current Investigation

The purpose of the current investigation is to characterize existing data gaps for IR-22 as follows:

- Collect water level measurements from existing A- and B-aquifer wells to calculate horizontal and vertical gradients
- Collect updated chemical data from existing A-aquifer monitoring wells in IR-22 to determine whether contaminated groundwater is impacting the Bay
- Conduct tidal studies to evaluate the extent of tidal influence, analyze patterns in groundwater flow, quantify tidal influence parameters, and characterize the TMZ in IR-22 (optional)
- Collect two rounds of groundwater samples from four wells in Parcel D as part of the basewide data gaps study of radionuclides in shallow groundwater

A3.3 PARCEL E

Areas of Parcel E where groundwater is significantly contaminated are located in IR-01/21, IR-02 Northwest, IR-02 Central, IR-02 Southeast, IR-03, IR-04, IR-05, IR-11/14/15, IR-12, IR-36, IR-39, IR-50, IR-56, IR-72, IR-73, and IR-75. A brief background of each IR site and a general description of the purpose of the current investigation at Parcel E are presented below.

A3.3.1 Background

No change.

A3.3.2 Purpose of the Current Investigation

The purpose of the current investigation is to characterize existing data gaps for IR sites in Parcel E as follows:

- Collect water level measurements from existing A- and B-aquifer wells to calculate horizontal and vertical gradients
- Collect updated chemical data from existing and newly installed B-aquifer wells to characterize the vertical extent of contamination on the basis of the drinking water pathway, particularly in areas where no Bay Mud aquitard separates the shallow A-aquifer from the underlying B-aquifer

- Collect updated chemical data from existing A-aquifer and bedrock water-bearing zone monitoring wells to confirm the horizontal extent of RUs, which are based on drinking water standards

- Conduct hydraulic tests to evaluate the hydraulic characteristics of the shallow aquifer system; calculate hydraulic parameters for the A-aquifer zone; evaluate hydraulic communication between the A-aquifer, B-aquifer, and bedrock water-bearing zones; and refine the hydrogeologic conceptual model for Parcel E

- Conduct tidal studies to evaluate the extent of tidal influence, analyze patterns in groundwater flow, quantify tidal influence parameters, and characterize the TMZ along the shoreline of Parcel E (optional)

- Collect two rounds of groundwater samples from 30 wells in Parcel E as part of the basewide data gaps study of radionuclides in shallow groundwater

A3.3.3 Hydrogeological Conceptual Model

From the surface downward, the hydrogeologic units at Parcel E consist of the A-aquifer, the Bay Mud aquitard, the B-aquifer, and the bedrock water-bearing zone. Groundwater levels measured in A-aquifer wells range from 1 to 15 feet bgs. The B-aquifer is present beneath most of Parcel E but is absent in IR-74 and in small portions of IR-02 Southeast, IR-04, IR-11/14/15, IR-56, and IR-72. Bay Mud generally separates the A- and B-aquifers. However, the Bay Mud is absent from parts of IR-01/21, IR-05, IR-56, IR-72, IR-73, and IR-76. Two bedrock monitoring wells are located in at IR-11, where an isolated mound of bedrock is located.

A total of 168 monitoring wells are located in Parcel E. One hundred fifty-three wells were screened in the A-aquifer (ranging from 2 to 49 feet bgs), 13 wells were screened in the B-aquifer (ranging from 11 to 78 feet bgs), and two wells were screened in bedrock (ranging from 18 to 28 feet bgs).

Analytes of concern include metals (arsenic, barium, and zinc), pesticides (dieldrin, endrin, and heptachlor epoxide), PCBs (Aroclor-1242 and Aroclor-1260), and VOCs (benzene, pentachlorophenol, PCE, and TCE). The sampling program for the Phase II GDGI was developed based on a detailed review of the historical data and consisted of 114 A-aquifer monitoring wells, 12 B-aquifer monitoring wells, and 2 bedrock monitoring wells. The Phase III GDGI sampling program duplicates the Phase II program, with the following modifications: (1) expanded sampling for analysis of radiological parameters (including speciation of various radionuclides) and (2) expanded sampling of the industrial landfill (IR-01/21) for typical analytes in groundwater at a landfill. Based on a review of the historical data and data from the Phase II GDGI, the Navy believes that the current sampling program adequately addresses the data needs at Parcel E. Data from the Phase II and Phase III GDGI will be evaluated, and future recommendations will be made in the Phase III information package for Parcel E.

The following section provides information on patterns of groundwater flow in Parcel E. The industrial landfill at IR-01/21 and areas of IR-03 are described separately because sheet pile walls that divert groundwater flow away from the Bay are present.

Patterns of Groundwater Flow

Groundwater flow in the A-aquifer at Parcel E is generally directed to the south and east. In the northwestern portion (IR-01/21 and IR-76), groundwater flows south, southeast, and southwest at orientations perpendicular to the coastline toward the Bay. In the northeastern portion of Parcel E (IR-04, IR-12, IR-56, and IR-72), groundwater flows east toward the large groundwater sink at northwestern Parcel D. Two isolated groundwater mounds have been identified at Parcel E, and a groundwater divide oriented parallel to the shore runs along the central coastline.

IR-01/21 Landfill

A 20-acre industrial landfill is located in IR-01/21. Between 1958 and 1974, the Navy filled the landfill with shipyard wastes, including construction and industrial debris, domestic refuse, an estimated 235,000 tons of sandblast waste, 13,000 gallons of paint sludge, and 8,000 gallons of solvents and waste oils. The zone of debris extends from approximately 7.5 to 22 feet bgs. A landfill cap was completed in the spring of 2001.

The saturated thickness of the A-aquifer at IR-01/21 is 1 to 16 feet. Bay Mud is absent and the A- and B-aquifers are in direct contact in the northwestern portion of IR-01/21. The B-aquifer is 50 to 158 feet thick where Bay Mud separates the A- and B-aquifers. Bedrock is estimated to occur at depths ranging from 50 to more than 250 feet below msl.

Groundwater in the A-aquifer at IR-01/21 flows predominantly to the south, southeast, and east. A sheet pile wall and groundwater extraction system were constructed along the shoreline of IR-01/21 in 1997.

IR-03

IR-03 was created by filling the Bay with quarried materials that consisted primarily of serpentinite rock from the HPS peninsula. Other materials used to fill the area include excavated Bay Mud, sand, gravel, construction debris, industrial debris, and sandblast waste. The shoreline is lined with concrete block riprap and buried barges. Two former oil reclamation ponds were constructed 30 feet from the shoreline but were emptied and filled with soil in 1974. The presence of VOCs, polynuclear aromatic hydrocarbons, PCBs, and petroleum hydrocarbons is likely a result of waste fuels and oils managed in the former ponds.

The saturated thickness of the A-aquifer at IR-03 ranges from 3 to 24 feet bgs. The Bay Mud aquitard appears to be laterally continuous beneath the A-aquifer. Groundwater levels measured in two B-aquifer monitoring wells were 4 and 8 feet bgs. Bedrock is estimated to occur at depths ranging from less than 50 to more than 150 feet below msl. Groundwater in the A-aquifer flows primarily to the north toward Parcel D except in areas directly adjacent to the shoreline. A sheet pile wall installed along the shoreline in 1997 slows the flow of groundwater into the Bay.

A3.4 RADIONUCLIDES

Sampling of groundwater for analysis of radionuclides throughout HPS is designed to provide ample coverage of the facility and to resolve data gaps related to radionuclide species in groundwater. This sampling effort will focus on groundwater downgradient of buildings and sites where radioactive materials were historically handled, stored, or disposed of and on areas where radioactively contaminated soil has been removed. Isotope-specific data are needed to evaluate whether site-related radioactive contamination occurs in groundwater at HPS, and if so, to delineate the extent of contamination. The following sections present the sampling locations and describe the purpose of the data gaps sampling and analysis of groundwater for radionuclides and radiological indicators.

A3.4.1 Problem Definition

Existing radiological data for samples collected at HPS consist mainly of screening-level analyses for radiological indicator parameters (gross alpha and gross beta) but include only a few results for specific radionuclides (for example, radium-226 and radium-228). Data for speciated radionuclides are needed to accurately describe the quality of groundwater in terms of radioactivity and to provide local background levels for specific isotopes. In addition, a large amount of data in the literature describes general background levels of specific radionuclides, such as K-40 in sea water, which has an average activity of approximately 300 pCi/L (U.S. Army Center for Health Promotion and Preventive Medicine 1999). More details on background radioactivity are presented along with summaries of site data in Appendices 4 and 5 of this QAPP addendum.

TSS is an important parameter that is needed to assess the quality of the sample and to evaluate the influence of suspended particles on the concentrations of chemicals in the water sample. By operational definition, water that is filtered in the field with a 0.45-micron membrane filter is said to contain "dissolved metals," whereas an unfiltered sample contains dissolved metals and additional metals that are adsorbed to or contained in suspended particles. This operational definition oversimplifies the transport of metals (including radionuclides) in the saturated subsurface environment. The standard 0.45-micron filter is based on the nominal size of bacteria and has little to do with the dissolved state of metals. In reality, metals (and other constituents) are present in particle sizes that range continuously from dissolved to colloids to particles (Hem 1992). A sample is needed that is representative of the mobile load of constituents in groundwater, and mobility depends on a number of physicochemical factors, as well as the type of aquifer.

Unless the aquifer is composed of clean sands or fracture-flow conditions dominate, samples collected by methods other than low flow (micropurge) sampling technique may contain nonrepresentative amounts of artificially suspended clay-size particles. After samples are collected and acidified to a pH less than 2.0 for preservation, metals desorb and particles dissolve in the acidified sample. Therefore, acidification and analysis of unfiltered groundwater samples collected by a bailer or other non-low-flow sampling techniques can lead to high and arbitrary results for concentrations of metals and other analytes (EPA 1994). For this reason, groundwater samples collected from a fine-grained aquifer should be either filtered in the field or obtained using micropurge sampling techniques to obtain samples that are representative of groundwater flowing through the aquifer under natural conditions. Data for TSS are needed to assess the effectiveness of the filtering or sampling technique and to evaluate whether a positive correlation exists between chemical concentrations and TSS.

In summary, review of existing radiological data for groundwater at HPS has indicated data gaps that require additional sampling and analysis for specific radionuclides to supplement the screening-level analyses represented by measurement of gross alpha and gross beta, both of which are nonspecific and do not distinguish among radionuclide species. In addition, critical supporting information (such as TSS concentrations) should be collected to ensure that analytical data are interpreted correctly.

A3.4.2 Background

Previous data gaps investigations of groundwater at HPS included a Phase I investigation of groundwater in Parcels C and D (TtEMI 2000a) and a Phase II investigation of groundwater in Parcels C, D, and E (TtEMI 2001a). After addenda to the FSP and QAPP for Phase II of the data gaps study were released, existing analytical data for radionuclides and radiological indicators (that is, gross alpha and gross beta) in groundwater were reviewed. The existing data for radionuclides and radiological indicators were plotted and evaluated to better ascertain data gaps. Appendix 4 of this QAPP addendum provides statistical graphs such as normal probability plots, histograms, and box-and-whisker plots. Although the plots assist in delineating data gaps, the data interpretation is limited by a lack of radionuclide-specific data, as well as a shortage of supporting information such as TSS concentrations.

The following sections summarize the background of the sites and previous investigations conducted in the parcels and IR sites. Complete background information, such as geologic data for the Bay area and HPS, and information about HPS and site-specific operational histories, environmental restoration, and the results of environmental investigation and analysis is presented in the RI reports (PRC 1996a, 1996b, 1997a, 1997b) and the FS reports (PRC 1996c, 1997c; TtEMI 1998a, 1998b). Sampling for the data gaps study of radionuclides in groundwater focuses on Parcel E, where the greatest percentage of samples has yielded detectable levels of gross alpha and gross beta. Tritium will be added to the radionuclide analytes for samples collected at wells downgradient of buildings (Building 364, 529, 707, 815, and 816) that are potential historical sources of tritium.

A3.4.2.1 Parcel B

For this study, one background well in Parcel B is proposed for sampling (UT03MW11A).

A3.4.2.2 Parcel C

Areas of significant groundwater contamination (nonradioactive) in Parcel C are located in IR-25 and IR-28. For this study, only well IR29MW57A, which is upgradient of known areas of contamination, will be sampled to help establish local levels of background radioactivity.

A3.4.2.3 Parcel D

The RI and FS reports for Parcel D (PRC 1996b, 1997c) concluded that groundwater at Parcel D does not pose an unacceptable risk to human health (through the inhalation pathway) or ecological aquatic receptors. However, several areas of potential concern were identified in sites IR-09, IR-33 North, IR-33 South, IR-34, and IR-71 during evaluation of groundwater at Parcel D on the basis of the drinking water pathway.

Several site wells and one background well (IR33MW62A) in Parcel D were selected for sampling to address the radiological data gaps study. A brief background of each IR site near wells proposed for sampling and a general description of the purpose of the radiological investigation at Parcel D are presented below.

IR-33 South

Operations at IR-33 South included a chemistry laboratory and hot cell (Building 364); a small animal holding area (Building 365); an area for storage of radioactive waste (Building 414); and a staging area for hazardous waste hauling, storage of equipment and waste, and cleaning and light maintenance of vehicles (Buildings 417, 418, and 424).

Storage of liquid radioactive wastes in tanks near Building 364, along with the soil removal actions started in 2001 (TtEMI 2001g), made it a candidate for the current investigation. One well in the area is proposed for sampling (Table 4-6 in the accompanying FSP addendum).

IR-34

The NRDL used rooms in Building 351A and Building 351, primarily for administration purposes. A former Boat and Plastics Shop (Building 366) was the former site of an NRDL X-ray unit and was used to store sealed radioactive sources. Several wells in the area are included on the list to be sampled for this data gaps study because NRDL used or stored radioactive material in Buildings 351A and 366 (Table 4-6 in the accompanying FSP addendum).

A3.4.2.4 Parcel E

Thirty wells in Parcel E were selected for sampling under this data gaps study. Of these 30 wells, 2 upgradient wells were selected as background wells (IR01MW31A and IR12MW20A). The remaining 28 wells are adjacent to or downgradient of buildings and sites where radioactive materials were historically handled, stored, or disposed of (Table 4-7 and Figure 4-5 in the accompanying FSP addendum).

Parcel E contains buildings and sites where radioactive materials were stored, handled, or inadvertently discarded in landfills. Existing data for radionuclides and radiogenic indicator parameters in samples of groundwater collected in Parcel E do not provide sufficient coverage for specific radionuclides to make defensible remedial decisions for groundwater. Sites of interest include IR-01/21, IR-02 Northwest, IR-02 Central, IR-02 Southeast, IR-03, IR-11/14/15, and IR-12. For this investigation, wells will be sampled and analyzed for a suite of radionuclides, radiological indicators, and supporting parameters (TDS, TSS, and pH). The suite of radionuclides includes americium-241, cesium-137, cobalt-60, europium-152 and -154, K-40, radium-226 and -228, strontium-90, and uranium-233, -235, and -238. A general description and brief background of each IR site in Parcel E are presented below.

IR-01/21

Radioactive compounds in groundwater are suspected at IR-01/21 as a result of buried radium dials and gauges and radium dials found near the surface that were subsequently removed (TtEMI 2001g). Wells IR01MW05A, IR01MW18A, IR01MW1-5, IR01MW07A, and IR01MW367A will be sampled as "site" wells, whereas well IR01MW31A will be sampled as a "background" well.

IR-02 Northwest

The known burial of radium dials and gauges necessitates sampling wells IR02MW126A, IR02MW141A, IR02MWB-2, and IR02MWB-3 for this data gaps study.

IR-02 Central

Several wells in IR-02 Central will be sampled to evaluate the possible presence of buried wastes contaminated with radionuclides.

IR-02 Southeast

The potential source of radiological contaminants at IR-02 Southeast is equipment with components that contained radium, mainly radium-226 in dials and gauges. Several wells in IR-02 Southeast will be sampled to evaluate the possible presence of buried wastes contaminated with radionuclides.

IR-03

Several wells (IR03-MW218A2 and IR03-MW218A3) in IR-03 will be sampled to evaluate the possible presence of radionuclides.

IR-11/14/15

NRDL occupied the existing building and several former buildings at IR-11/14/15 in the early 1950s. Additional sampling was deemed necessary to evaluate activities of radionuclides and radiological indicators during an assessment of radiological data gaps for groundwater at Parcel E. Therefore, groundwater samples will be collected from wells IR14MW09A, IR14MW10A, and IR14MW12A.

IR-12

For the current study, one well hydraulically upgradient of Building 707 will be sampled as a background well for analysis of radionuclides (IR12MW20A). Wells downgradient of IR-12 that lie within IR-02 will also be sampled.

A4 PROJECT AND TASK DESCRIPTION

This section summarizes the objectives of and the tasks necessary to complete the Phase III GDGI HPS. The primary objectives, types of data to be collected, quality standards and criteria for the data, and project documentation are discussed below. The DQO steps for the project are presented in Table A-3 of this QAPP addendum. A general discussion of the DQO steps is provided in Section A1.4 of this QAPP addendum, and specific details related to each DQO step are discussed throughout this document.

A4.1 PROJECT OBJECTIVES

The overall project objective is to better characterize the hydrogeology and the extent of contaminant plumes in groundwater at HPS. Specific project objectives, as related to the resolution of study questions, are discussed in detail in Section A1.4.

A4.2 PROJECT MEASUREMENTS

The analytical methods were selected to provide data of the quality necessary to meet the DQOs for this project and to maintain consistency and comparability of the data. The data collected under the current groundwater monitoring program must be comparable with data for groundwater collected previously at HPS to allow evaluation of decisions identified through the DQO process (Section A1.4). To promote comparability of data with previous analytical results, standard EPA methods were chosen for most analyses. Laboratory analytical methods and corresponding detection and reporting limits are presented in Appendix 2 of this QAPP addendum.

The analytical methods for radionuclides were selected to provide data of the quality necessary to meet the DQOs for radiological data gaps sampling and to maintain consistency and comparability of the data. The data collected under the proposed data gaps sampling will be compared to the extent possible with data previously collected for groundwater samples at HPS. As noted previously, most of the existing data are for radiogenic indicators rather than for specific radionuclides. The newly acquired data will be statistically compared with regulatory limits and background data to allow evaluation of decisions identified through the DQO process.

Methods from "Methods for the Chemical Analysis of Water and Waste" (EPA 1983) were chosen for the analysis of nonradiogenic components, as well as for radiogenic compounds to be analyzed by gamma and alpha spectroscopy to promote comparability of data with previous analytical results. Radium-228 will be analyzed using EPA Method 9320. Laboratory analytical methods and corresponding reporting limits and MDAs are presented in Appendix 2 of this QAPP addendum.

A4.3 PROJECT QUALITY STANDARDS AND CRITERIA

No change.

A4.4 PROJECT DOCUMENTATION

No change; field forms are unchanged but are included in Appendix 1 of this QAPP addendum.

A5 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The seven-step DQO process described in EPA QA/G-4 (EPA 2000a) was used to develop quality objectives for this project, as presented in Sections A1 and A3. The specific quality objectives and criteria for measurement data as they apply to this project are discussed in the following sections.

A5.1 PROJECT SCOPE AND ENVIRONMENTAL MEDIA

Groundwater samples will be collected from selected monitoring wells in Parcels C and D (Table 4-3 of the accompanying FSP addendum). Samples from each site will be analyzed for a subset of the following analytes of concern and suites of analytes: VOCs; SVOCs; pesticides and PCBs; dissolved metals; hexavalent chromium; gross alpha and beta radioactivity; organophosphates; cyanide; ammonia nitrogen; total kjeldhal nitrogen; sulfide; TSS; and specific radionuclides and MNA parameters. Radionuclides include americium-241; cesium-137; cobalt-60; europium-152 and –154; K-40; radium-226 and –228; strontium-90; and uranium-233, -235, and -238. MNA parameters include methane, ethane, ethene, Fe^{2+}, ferric iron, manganese (II), nitrate, nitrite, sulfate, total alkalinity, carbonate alkalinity, bicarbonate alkalinity, hydroxide alkalinity, dissolved oxygen, oxidation-reduction potential, chloride, calcium, magnesium, sodium, potassium, and TDS. The analytical suite for samples from each monitoring well is identified in Table 4-3 of the accompanying FSP and the corresponding groundwater monitoring schedule is presented in Table 8-1 of the accompanying FSP.

Water levels will be measured during each sampling event for all wells. In situ measurement of groundwater parameters, including dissolved oxygen, oxygen-reduction potential, pH, temperature, specific conductivity, and Fe^{2+}, will be collected during groundwater sampling. Investigation-derived waste will be handled according to the procedures outlined in Section 4.8 of the accompanying FSP.

A5.2 INTENDED DATA USERS AND USES

No change.

A5.3 DATA TYPE AND QUANTITY

No change.

A5.4 ACCEPTABLE LEVEL OF CONFIDENCE IN THE DATA

No change.

A5.5 SPECIFYING PERFORMANCE CRITERIA: PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS, AND COMPARABILITY PARAMETERS

No change; precision and accuracy goals for each analytical method are presented in Appendix 3 of this QAPP.

A5.6 DETECTION AND QUANTITATION LIMITS

Tables of detection limits for analytes specified for the project are included in Appendix 2 of this QAPP addendum. The instrument detection limit (IDL) is the minimum concentration of an analyte that can be distinguished from the normal electronic noise of an analytical instrument. The MDA is the minimum radioactivity that can be distinguished from the normal electronic noise of an analytical instrument and from the inherent background activity in the laboratory. The reporting limit represents the lowest concentration at which an analyte can be accurately and reproducibly quantified. Project-required quantitation limits (PRQL) are the minimums that are contractually required for analysis by laboratory contractors. The PRQL for this project was adapted from the drinking water levels in the "Groundwater Nuclide Analysis Report for Mare Island Naval Shipyard" (Supervisor of Shipbuilding, Conversion, and Repair, Environmental Detachment, Portsmouth, Virginia 1997). The required detection limits are found in Table 2-2 in Appendix 2 of this QAPP addendum.

Samples analyzed for metals for this project will be reported as estimated values if concentrations are less than PRQLs but greater than instrument detection limits. Samples analyzed for organic compounds will be reported as estimated values if the concentrations are less than PRQLs but greater than the method detection limits. The IDL for each inorganic analyte will be listed as the detection limit in the laboratory's electronic data deliverable to prevent the statistical evaluations from being affected by high value nondetect results.

A6 DOCUMENTATION AND RECORDS

No change.

B1 MEASUREMENT AND DATA ACQUISITION

No change.

B2 SAMPLING DESIGN (EXPERIMENTAL DESIGN)

No change.

B3 SAMPLING METHODS

No change.

B4 SAMPLE HANDLING, CUSTODY, AND SHIPPING PROCEDURES

No change.

B5 ANALYTICAL METHODS

Appendix 2 of this QAPP presents the analytical methods and corresponding detection and reporting limits. The analytical methods were selected to provide data of the necessary quality to meet the DQOs for this project and to maintain consistency and comparability of data. The data collected under the current groundwater monitoring program must be comparable with groundwater data collected previously at HPS to allow evaluation of decisions identified through the DQO process (Section A1.4). Standard EPA methods were chosen for most analyses to promote comparability of data with previous analytical results. A subcontract laboratory using methodologies approved by EPA for which it has been certified by the California Department of Health Services through the Environmental Laboratory Accreditation Program and approved by the Navy will analyze the samples. Any modifications to the analytical methods presented in Appendix 2 will be submitted to the Navy and regulatory agencies for review before they are used.

The laboratory analytical, data reporting, and validation procedures will be carried out in accordance with the provisions of the "Navy Installation Restoration Chemical Data Quality Manual" (Naval Facilities Engineering Service Center 1999) and the protocols documented in this QAPP. A minimum of 20 percent of all analytical data received from the laboratory will be subjected to full validation, as described in Section D1; the remaining 80 percent will undergo cursory validation, as described in Section D1. Subcontracted laboratories will retain a staff that possesses analytical expertise in (1) organic and inorganic analyses (including analysis of radionuclides), (2) QA/QC procedures, (3) production of contract laboratory program-type data packages, and (4) operation and maintenance of the laboratory information management system. The laboratory will have sufficient qualified personnel and appropriate analytical instruments available to technically and contractually carry out work required for the Phase III GDGI. The contract-required quantitation and detection limits for the methods are listed in Appendix 2 of this QAPP.

Field measurements will be made by methods identical to those used in previous events. In situ measurements of groundwater parameters will be collected with a high-precision water quality meter connected to a flow-through cell, as detailed in Section 4.3.3 of the accompanying FSP addendum.

B6 QUALITY CONTROL

The primary functions of a sampling and analysis program are to obtain accurate, representative environmental samples and to provide defensible analytical data. A program for evaluating field and laboratory data was developed to achieve those goals. The quality of the field data will be assessed through regularly scheduled collection and analysis of field QC samples. Laboratory QC samples will also be analyzed in accordance with referenced analytical method protocols to ensure that laboratory procedures and analyses are conducted properly.

The following sections discuss the types of QC samples to be collected and analyzed for this project and their role in the assurance of acceptable project data. Additional QC procedures are not limited to the measures discussed in this section. Field and laboratory personnel may implement additional procedures in accordance with specific method protocols. The sections below also discuss field QC samples, QC procedures for field measurements, laboratory QC samples, and laboratory QC procedures.

B6.1 FIELD QUALITY CONTROL SAMPLES

No change.

B6.2 QUALITY CONTROL PROCEDURES FOR FIELD MEASUREMENTS

No change.

B6.3 LABORATORY QUALITY CONTROL SAMPLES

Laboratory QC samples are analyzed to evaluate the quality of preparation and analysis of field samples. Laboratory QC samples are prepared and analyzed at the laboratory to assess analytical precision, accuracy, and representativeness. The types of laboratory QC samples that will be used are discussed below.

B6.3.1 Method Blanks

No change.

B6.3.2 Laboratory Control Samples or Blank Spikes

No change.

B6.3.3 Matrix Spike and Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples are analyzed to evaluate the suitability of an analytical method for an environmental sample matrix. A known concentration of target analytes is added to an aliquot of the field sample used in preparing the MS sample. MSs and MSDs measure the efficiency of all the steps of the analytical method in recovering target analytes from an environmental sample matrix. The percent recoveries will be calculated for each of the spiked analytes and used to evaluate analytical accuracy. The relative percent difference (RPD) between matrix spike and matrix spike duplicate samples will be calculated to evaluate reproducibility. For inorganic analyses, a matrix duplicate is analyzed, rather than an MSD. Evaluation of precision is based on comparison of the results of duplicate and original analyses.

MS and MSD samples are analyzed at a frequency of 5 percent. Additional sample volume will be collected for MS and MSD for water samples. If the MS and MSD percent recoveries used to assess accuracy or the RPD results used to assess precision are outside the established acceptance limits, method-specific protocols will be followed to evaluate the usability of the data. Laboratory control samples or blank spikes, if available, will be examined to evaluate the effect of the out-of-control event on the reported results. Control limits for the evaluation of accuracy and precision for the MS and MSD are provided in Appendix 3 of this QAPP.

The precision of the analysis for TDS and TSS will be assessed using the RPD between results. The duplicate RPD criterion for TDS and TSS is 25 percent. The duplicate precision for radionuclides is measured as duplicate error ratio (DER) and Control Limit. The DER warning limit is 1.42, and the control limit is 2.13. A DER between 1.42 and 2.13 will be narrated, but no formal corrective action will be required. A DER greater than 2.13 will require some form of corrective action, which will normally be to re-prepare the affected batch of samples.

The DER is calculated using the equation shown below.

$$DER = \frac{|S_A - D_A|}{2\sqrt{\left(\frac{TPU_S}{2}\right)^2 + \left(\frac{TPU_D}{2}\right)^2}}$$

where:

S_A	=	Sample activity
D_A	=	Duplicate activity
TPU_S	=	Sample total propagated uncertainty
TPU_D	=	Duplicate total propagated uncertainty

B6.3.4 Surrogate Standards

No change. Guidelines for surrogate recovery for this project are provided in Appendix 3 of this QAPP.

B6.3.5 Internal Standards

No change.

B6.4 LABORATORY CONTROL PROCEDURES

No change

B7 TESTING, INSPECTION, AND MAINTENANCE OF INSTRUMENTS AND EQUIPMENT

No change.

B8 INSPECTION AND ACCEPTANCE FOR SUPPLIES AND CONSUMABLES

No change.

B9 NONDIRECT MEASUREMENTS

No change.

C1 ASSESSMENTS AND RESPONSE ACTIONS

No change.

D1 DATA VALIDATION AND USABILITY

No change.

D2 RECONCILIATION WITH DATA QUALITY OBJECTIVES

DQOs for the Phase III GDGI are presented in Section A1.4 and Table A-3. The sampling and laboratory methods described in this QAPP, combined with data collected during previous phases of the GDGI, should provide data of sufficient quality and quantity to conduct a complete assessment of the data gaps identified for groundwater at HPS.

The following paragraphs describe the reconciliation process specific to the radiological data gaps study. A more rigorous process, as described below, is necessary to properly evaluate the radiological data.

Radiological Data Gaps Study

Data collected during the radiological data gaps study will be reconciled with the DQOs through (1) statistical and geochemical evaluation of the data and (2) a comparison of the data with applicable criteria established in the DQOs in accordance with EPA guidance for data quality assessment (DQA) (EPA 2000b). The DQA process comprises the following five steps:

- Review of the project DQOs (Table A-3 and Section A1.4)
- Conduct a preliminary review of the data, including plots and figures if appropriate
- Select a statistical test that is appropriate to apply based on the characteristics of the data collected
- Verify the assumptions of the statistical test (for example, data are for random and independent samples, the distribution follows a normal curve, and other common test assumptions)
- Formulate conclusions based on the quality of the data and the results of statistical tests and geochemical analysis

The first step of the DQO process (Table A-3) stated the following problem for the radiological data gaps investigation:

- Areas of radioactively contaminated soils have been identified and removed from HPS; however, existing data for radionuclides and radiological indicator parameters (gross alpha and gross beta) in samples of sitewide groundwater and soils collected in Parcel E do not provide sufficient coverage to make defensible remedial decisions for groundwater. Data are also limited for local background activities of specific radionuclides. (Most of the existing data are for radiological indicators such as gross alpha and gross beta.) Isotope-specific data are needed to evaluate whether site-related radioactive contamination occurs in groundwater at HPS, and if so, to delineate the extent of contamination.

The sampling and laboratory methods described in this QAPP should provide adequate data to evaluate radioactivity in shallow groundwater at HPS. Because radioactivity is present naturally in the environment and consists of "primordial" radioactivity and cosmic radiation, it is critical to identify naturally occurring background levels (Appendix 5). In addition, since the beginning of the nuclear age, an anthropogenic background of fallout radiation exists from aboveground explosions of nuclear weapons and accidental releases from nuclear power plants such as Chernobyl. Data collection and evaluation conducted under this data gaps investigation will establish background activities from any site-related radioactive contamination of shallow groundwater at HPS.

As discussed in Step 6 of the DQOs (Section A1.4.6), appropriate statistical tests will be applied to the data. The data evaluation will be conducting in accordance with EPA (2000b) and Navy (1999) guidance for statistically evaluating site and background data and will include data presented graphically using box-and-whisker and probability plots or other suitable figures.

Data evaluation will follow the DQA process to the extent possible to verify that the type, quality, and quantity of data collected are appropriate for their intended use. In cases where the five-step DQA process is not followed completely because the DQOs are qualitative, the quality and usability of the data will still be systematically assessed. This assessment will include:

- A review of the sampling design and sampling methods to verify that they were implemented as planned and are adequate to support the objectives of the project

- A review of project-specific data quality indicators for the PARCC parameters and quantitation limits to evaluate whether acceptance criteria have been met

- A review of project-specific DQOs to evaluate whether they have been achieved by the data collected

- An evaluation of any limitations associated with the decisions to be made based on the data collected. For example, if data completeness is only 90 percent compared with a project-specific completeness objective of 95 percent, the data may still be usable to support a decision, but at a lower level of confidence.

At the conclusion of the project, the project chemist will prepare a quality control summary report (QCSR) that summarizes the overall quality of the data and evaluates whether MQO were met. In addition to the PARCC criteria, specific items to be reviewed include:

- Data completeness for each site location
- Evaluation of quantitation limits against decision criteria or action levels
- Nonconformance issues that might necessitate resampling

The QCSR is intended to provide a general overview of data quality for the project. The QCSR will summarize the results of the data validation process and the evaluation of the PARCC criteria and will evaluate the ability of the analytical data to support DQOs. The data validation narratives, which document specific details of the validation process, will be included in an appendix to the QCSR. The QCSR and final report for the project will discuss any potential effects on data usability and will clearly define any limitations associated with the data.

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FIGURES

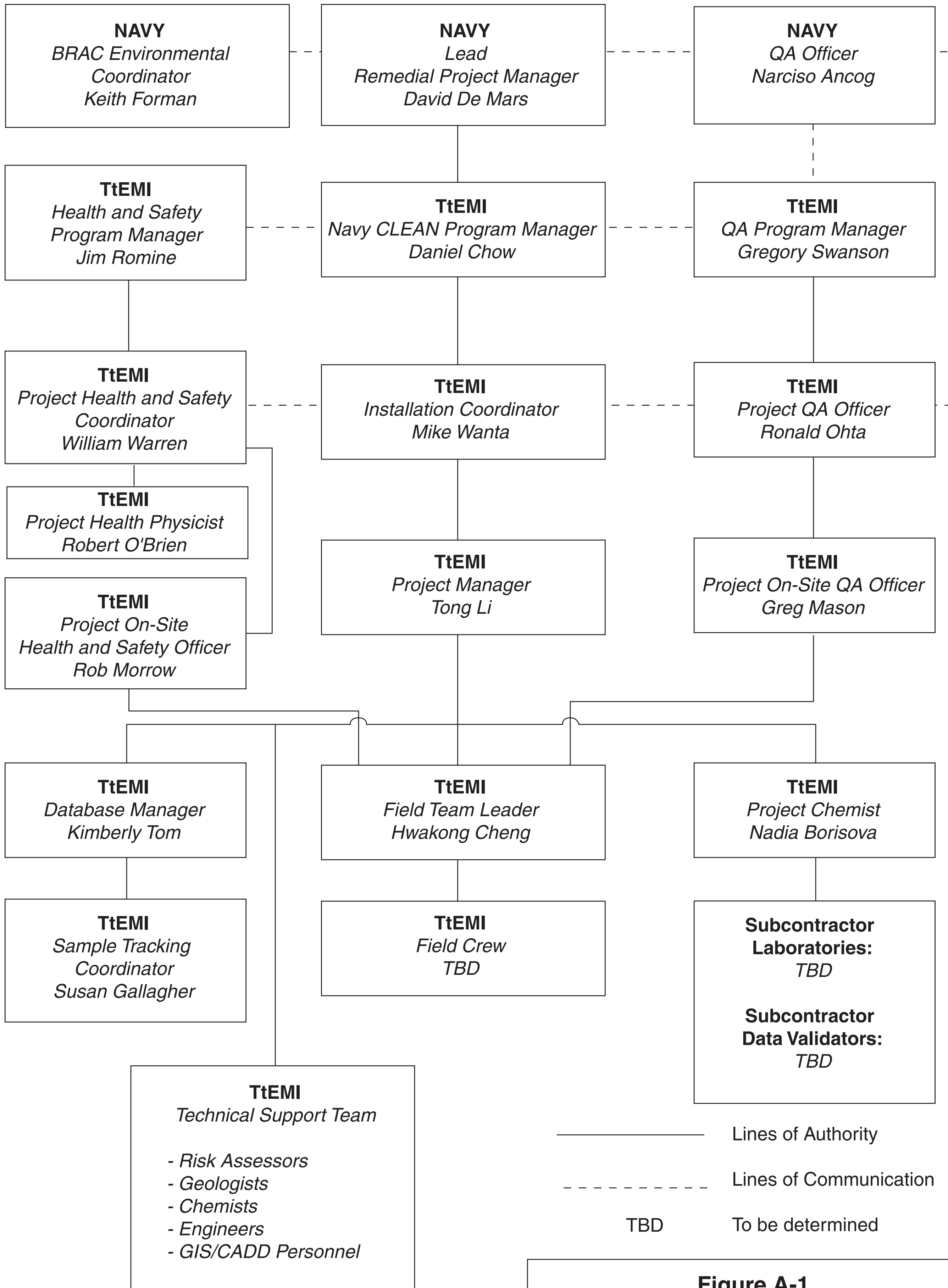


Figure A-1
Groundwater Data Gaps Investigation Organization Flowchart

S:/CLEAN/HPS (jdb)/Basewide GW Sampling/FSP_QAPP_Addemd_Ph_III/Draft

APPENDIX 1

FIELD FORMS AND QUALITY CONTROL REPORTS

Field Instrument Calibration Log

CTO No.: ____________________________________

Project Name: ____________________________________

Instrument Type	Instrument SN	Calibration Type	Date	By

TETRA TECH EM INC.
MONITORING WELL INSPECTION FORM

Monitoring Well No.:_______________ **Date:**_______________

Detail the condition of the items identified below, as applicable to each individual well:

External well identification:

Internal well identification:

Concrete pad and surrounding area:

Well vault or stickup:

Well lid (if applicable):

Rubber seal (if applicable):

Lid bolts (if applicable):

Well cap:

Well lock:

Water level measuring mark and/or notch:

Was there standing water in the well vault/well stickup? Yes_____ No_____

Note any abnormalities regarding the well vault in relation to the surrounding grade:

(inspection information continued on reverse)

TETRA TECH EM INC.
MONITORING WELL INSPECTION FORM
(CONTINUED)

If necessary, using the following space, note any discrepancies between the well location portrayed on the well location map and the location of the well as identified in the field.

Location sketch:

Identify all light maintenance completed during well inspection:

Additional Comments:

Prepared by:____________________________

TETRATECH EM INC

MONITORING WELL COMPLETION RECORD

MONITORING WELL
MONITORING WELL NO.: ____
PROJECT: ____
SITE: ____
BOREHOLE NO.: ____
WELL PERMIT NO.: ____
TOC TO BOTTOM OF WELL: ____

DRILLING INFORMATION
DRILLING BEGAN:
DATE: ____ TIME: ____
WELL INSTALLATION BEGAN:
DATE: ____ TIME: ____
WELL INSTALLATION FINISHED:
DATE: ____ TIME: ____
DRILLING CO.: ____
DRILLER: ____
LICENSE: ____
DRILL RIG: ____
DRILLING METHOD:
- ☐ HOLLOW STEM AUGER
- ☐ AIR ROTARY
- ☐ OTHER: ____

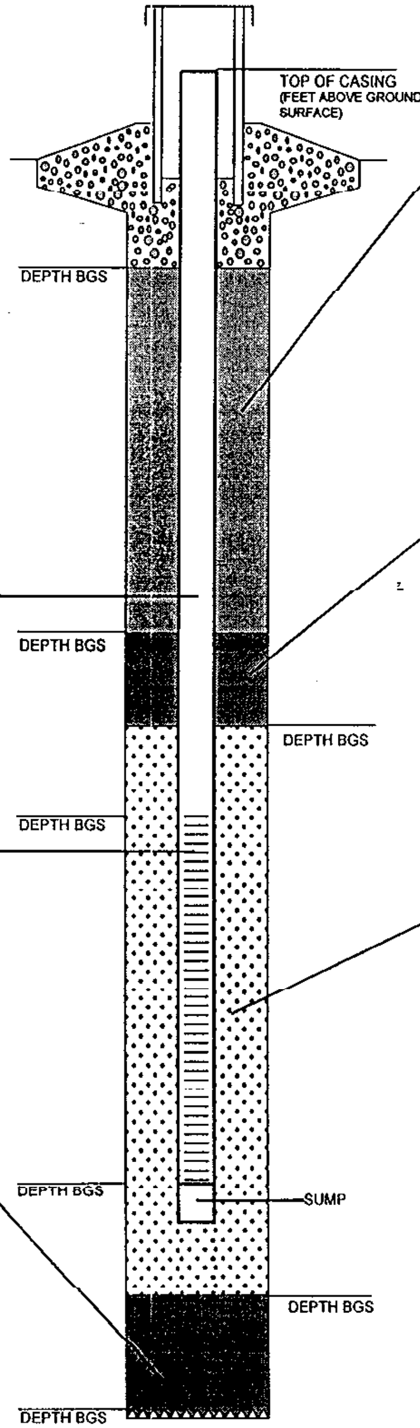
DIAMETER OF AUGERS:
ID: ____ OD: ____

WELL CASING
☐ SCHEDULE 40 PVC
☐ OTHER: ____
PRODUCT: ____
MFG. BY: ____
CASING DIAMETER:
ID: ____ OD: ____
LENGTH OF CASING: ____

WELL SCREEN
☐ SCHEDULE 40 PVC
☐ OTHER: ____
PRODUCT: ____
MFG. BY: ____
CASING DIAMETER:
ID: ____ OD: ____
SLOT SIZE: ____
LENGTH OF SCREEN: ____

BOREHOLE BACKFILL
AMOUNT CALCULATED: ____
AMOUNT USED: ____
☐ BENTONITE CHIPS, SIZE: ____
☐ BENTONITE PELLETS, SIZE: ____
☐ SLURRY: ____
☐ FORMATION COLLAPSE: ____
☐ OTHER: ____
PRODUCT: ____
MFG. BY: ____
METHOD INSTALLED:
☐ POURED ☐ TREMIE
☐ OTHER: ____

SURFACE COMPLETION
☐ FLUSH MOUNT
☐ ABOVE GROUND WITH BUMPER POST
☐ CONCRETE ☐ ASPHALT



SURVEY INFORMATION
TOC ELEVATION: ____
GROUND SURFACE ELEVATION: ____
NORTHING: ____
EASTING: ____
DATE SURVEYED: ____
SURVEY CO.: ____

ANNULAR SEAL
VOLUME CALCULATED: ____
AMOUNT USED: ____
☐ GROUT FORMULA (PERCENTAGES)
PORTLAND CEMENT: ____
BENTONITE: ____
WATER: ____
☐ PREPARED MIX
PRODUCT: ____
MFG. BY: ____
METHOD INSTALLED:
☐ POURED ☐ TREMIE
☐ OTHER: ____

BENTONITE SEAL
VOLUME CALCULATED: ____
AMOUNT USED: ____
☐ PELLETS, SIZE: ____
☐ CHIPS, SIZE: ____
☐ OTHER: ____
PRODUCT: ____
MFG. BY: ____
METHOD INSTALLED:
☐ POURED ☐ TREMIE
☐ OTHER: ____
AMOUNT OF WATER USED: ____

FILTER PACK
☐ PREPACKED FILTER
VOLUME CALCULATED: ____
AMOUNT USED: ____
☐ SAND, SIZE: ____
PRODUCT: ____
MFG. BY: ____
METHOD INSTALLED:
☐ POURED ☐ TREMIE
☐ OTHER: ____
WATER LEVEL: ____
(BTOC AFTER WELL INSTALLATION)

CENTRALIZERS USED?
☐ YES ☐ NO;
CENTRALIZER DEPTHS: ____

LEGEND
BGS = BELOW GROUND SURFACE
BTOC = BELOW TOP OF CASING
N/A = NOT APPLICABLE
NR = NOT RECORDED
TOC = TOP OF CASING

TETRA TECH EM INC.
GROUNDWATER LEVEL MEASUREMENTS LOG

Circle type of organic vapor meter used: PID FID

Well Number	PID/FID Reading (ppm)	Time	Depth to Groundwater (ft.) (three measurements)			Depth to Bottom (ft.)	Comments
			1st	2nd	3rd		

Date: ____________________

Field Staff: ______________________________ Field Staff Signature: ______________________________

Page No.: __________

Tetra Tech EM Inc.

MICROPURGING GROUNDWATER SAMPLING DATA SHEET

Page ____ of __

Date ________

Well Name ____________________ Screen Interval ____________________

Project ____________________ Station Elevation ________ GND ____ TOC ______ Immiscible Phases Present ☐ Yes ☐

Project No. ____________________ Static Water Level (from TOC) ____________________ Type ____________________

Well Location ____________________ Well Stick Up ____________________ Measured with ____________________

Sample Date ____________________ Static Elevation ____________________ PID Readings (background) ____________________

Sampling Personnel ____________________ Well Depth __________ MEAS ____ RPTD ______ PID Reading (TOC) ____________________

____________________ Feet of Water ____________________ Wells Installed by ____________________

____

Sample ID ____________________ Gallons/Foot ____________________ Installation Date ____________________

Duplicate ID ____________________ Casing Volume ____________________ Development Date(s) ____________________

FIELD CHEMISTRY CALIBRATIONS

Date/Time ____________________ Spec. Conductance: Standard ________ μmhos/cm at 25•C Reading ________ μmhos/cm at __

pH: pH 4.00 - ______ at ________ •C pH 7.00 - ______ at ________ •C pH 10.00 - ______ at ______ •C Slope ________

Dissolved Oxygen: D.O. Meter _______ mg/L at ______ •C PID: Calibration Gas _________ PPM ______ Span ______ Reading ________

PURGING													
								Cumulative Volume of Water Removed (Purged)		PID/OVA Reading			
Time	Discharge Rate (mL/min)	Dissolved Oxygen (mg/L)	pH	Eh/ORP (mV)	Temp. (•C)	Specific Conduct. (μmhos/cm at •C)	Turbidity (NTU)	Gallons	Casing Vol.	Location	Value	Depth to Water (ft)	Comments

SAMPLE PARAMETERS

Condition of well: ____________________

Remarks: ____________________

FIELD EQUIPMENT

pH Meter ____________________ Serial Number ____________________

Spec. Cond. Meter ____________________ Serial Number ____________________

Pump ____________________ Serial Number ____________________

Water Level Meter ____________________ Serial Number ____________________

D.O. Meter ____________________ Serial Number ____________________

Filter Apparatus ____________________ Filters ____________________

Temperature Measure ____________________

Interface Probe ____________________ Serial Number ____________________

PID/OVA ____________________ Serial Number ____________________

Field Chemistry Calibrations

Fractions ____________________

____

____

Number of Bottles ____________________

Sample Depth ____________________

Field Notebook ____________________

Sample Method ____________________

____

Discharge Water Containerized ☐ Yes ☐ No

Tet: ech EM Inc.
San Francisco Office

135 Main St. Suite 1800
San Francisco, CA 94105
415-543-4880
Fax 415-543-5480

J440

Chain of Custody Record

Page ______ of ______

PO#	Lab:

Project name:	TtEMI technical contact:	Field samplers:
Project number:	TtEMI project manager:	Field samplers' signatures:

No./Container Types: 40 ml VOA, 1 Liter Amber, 1 Liter Poly, Brass Tube, Glass Jar

Preservative Added

Analysis Required: CLP VOA, CLP SVOA, CLP Pest/PCBs, CLP Metals, TPH Purgeables, TPH Extractables

Sample ID	Sample Description/Notes	Date	Time	Matrix	40 ml VOA	1 Liter Amber	1 Liter Poly	Brass Tube	Glass Jar				CLP VOA	CLP SVOA	CLP Pest/PCBs	CLP Metals	TPH Purgeables	TPH Extractables									

EXAMPLE

	Name (print)	Company Name	Date	Time
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				

Turnaround time/remarks:

Tetra Tech EM Inc.

Daily Quality Control Report

(Page 1 of 2)

Project Name:	**Date:**
Project Number:	**Day:**
Weather:	**Wind:**
Temperature:	**Humidity:**

Personnel on Site

Field Team Leader:

Subcontractors on Site:

Equipment on Site

Work Performed (Including Sampling)

Quality Control Activities

Health and Safety Levels and Activities

Problems Encountered / Corrective Action Taken

Tetra Tech EM Inc.

Daily Quality Control Report

(Page 2 of 2)

Deviations from Field Work Plan

Additional Notes

Anticipated Activities for Tomorrow

Distribution:	**Submitted By:**
	Signature Date

Audit Report

Tetra Tech EM Inc.

Project Name: ______________________ **Date of Audit:** ______________________

Project No.: ______________________ **Project Manager:** ______________________

Audit Team Members: ______________________

Brief Description of Project:

____

____

Audit Summary:

____

____

Corrective Action Required:

____

____

Quality Improvement Opportunities:

____

____

Remarks:

____

____

Auditor Signature: ______________________ Date: ______________________

cc: TtEMI Program QA Manager

Corrective Action Request Form
(Page 1 of 2)

Tetra Tech EM Inc.

Project Name: ______________________ **Date:** ______________

Project No.: ______________________ **Project Manager:** ______________

Location: ____

To (Project Manager): __________________________________

From (Audit Team Members): ______________________________

Description Problem:

____

____

____

____

Corrective Action Required:

____

____

____

____

The above corrective action must be completed by (Date): ______________

Acknowledgement of Receipt

____

(Signature and Date)

Corrective Action Request Form

(Page 2 of 2)

Tetra Tech EM Inc.

Corrective Action Taken:

____

____

____

____

Project Manager: ______________________________

(Signature and Date)

Audit Team Members:

Corrective Action *is / is not* satisfactory

____

(Date and Initial)

Remarks: ______________________________

QC Coordinators:

Corrective Action *is / is not* satisfactory

____

(Date and Initial)

Remarks: ______________________________

cc: Program QA Manager

APPENDIX 2

ANALYTICAL METHODS PROTOCOL

TABLE 2-1

ANALYTICAL PROTOCOLS FOR GROUNDWATER
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Analysis	Method/ Reference	Sample Volume, Container	Extra MS/MSD Volume	Preservation	Analytical Holding Time
Off-Site Laboratory Analyses – Analytes of Concern					
Volatile Organic Compounds (VOCs)	EPA 8260B	Three 40-mL VOC vials Gray butyl/ Teflon-lined caps	Three 40-mL VOC vials	Sample must be collected without headspace Preserve with HCl to pH ≤ 2 and cool to 4°C	14 days (7 days if unpreserved)
Semivolatile Organic Compounds (SVOCs)	EPA 8270C[a]	Two 1-L amber glass containers	Two 1-L amber glass containers	Unpreserved Cool to 4°C	7 days[b]
Pesticides/Polychlorinated biphenyls (PCBs)	EPA 8081/8082	Two 1-L amber glass containers	Two 1-L amber glass containers	Unpreserved Cool to 4°C	7 days[b]
Organophosphorus Compounds	EPA 8141A	One 1-L amber glass container	One 1-L amber glass container	Unpreserved Cool to 4°C	7 days[b]
Metals (Dissolved)	EPA 6010B	One 500-mL polyethylene container	One 500-mL polyethylene container	Field-filtered (to 0.45 µm) Preserve with HNO_3 to pH<2 and cool to 4°C	Hg: 28 days Others: 6 months
Hexavalent Chromium	EPA 7196A	One 500-mL polyethylene container	One 500-ml polyethylene container	Filtered at laboratory Unpreserved Cool to 4°C	24 hours
Cyanide	EPA 9010	One 500-mL polyethylene container	One 500-mL polyethylene container	Preserve with NaOH to pH>12	14 days
Fluoride	EPA 340.2	One 250-mL polyethylene container	One 250-mL polyethylene container	Unpreserved Cool to 4°C	28 days

TABLE 2-1 (Continued)

ANALYTICAL PROTOCOLS FOR GROUNDWATER
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Analysis	Method/ Reference	Sample Volume, Container	Extra MS/MSD Volume	Preservation	Analytical Holding Time
Off-Site Laboratory Analyses – Analytes of Concern (Continued)					
Gross Alpha and Beta	EPA Method 9310	One 1-L polyethylene container	One 1-L polyethylene container	Preserve with HNO_3 to pH<2	180 days
Radium-226	EPA Method 9315	One 1-L polyethylene container	One 1-L polyethylene container	Preserve with HNO_3 to pH<2	7 days
Radium-228	EPA Method 9320	One 1-L polyethylene container	One 1-L polyethylene container	Preserve with HNO_3 to pH<2	7 days
Americium-241	ASTM D3972-90M	One 1-L polyethylene container	One 1-L polyethylene container	Preserve with HNO_3 to pH<2	7 days
Cesium-137	EPA 901.1M, MCAWW	One 1-L polyethylene container	One 1-L polyethylene container	Preserve with HNO_3 to pH<2	7 days
Cobalt-60	EPA 901.1M, MCAWW	One 1-L polyethylene container	One 1-L polyethylene container	Preserve with HNO_3 to pH<2	7 days
Europium-152	EPA 901.1M, MCAWW	One 1-L polyethylene container	One 1-L polyethylene container	Preserve with HNO_3 to pH<2	7 days
Europium-154	EPA 901.1M, MCAWW	One 1-L polyethylene container	One 1-L polyethylene container	Preserve with HNO_3 to pH<2	7 days
Potassium-40	EPA 901.1M, MCAWW	One 1-L polyethylene container	One 1-L polyethylene container	Preserve with HNO_3 to pH<2	7 days
Tritium	EPA 906, MCAWW	500-mL amber glass container	500 mL amber glass container	Unpreserved Cool to 4°C	7 days
Isotopic Uranium	ASTM D3972-90M	One 1-L polyethylene bottle	One 1-L polyethylene bottle	Preserve with HNO_3 to pH<2	7 days

TABLE 2-1 (Continued)

ANALYTICAL PROTOCOLS FOR GROUNDWATER
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Analysis	Method/ Reference	Sample Volume, Container	Extra MS/MSD Volume	Preservation	Analytical Holding Time
Off-Site Laboratory Analyses – Analytes of Concern (Continued)					
Strontium-90	ASTM D5811-95M	One 1-L polyethylene bottle	One 1-L polyethylene bottle	Preserve with HNO_3 to pH<2	7 days
Nitrite-N/Nitrate-N (NO_2^-/NO_3^-)	EPA 353.1, MCAWW	Two 40-mL VOC vials	Not applicable	Preserve with H_2SO_4 Cool to 4°C	48 hours
Sulfate/Chloride	EPA 300.0	One 500-mL polyethylene container	Not applicable	Unpreserved Cool to 4°C	28 days
Sulfide	EPA 376.2	One 500-mL polyethylene container	One 500-mL polyethylene container	Preserve with NaOH+ZnAC Cool to 4°C	7 days
Ammonia Nitrogen	EPA 350.1	One 250-mL polyethylene container	One 250-mL polyethylene container	Preserve with H_2SO_4 Cool to 4°C	28 days
Total Kjeldhal Nitrogen	EPA 351.4	One 1-L polyethylene container	One 1-L polyethylene container	Preserve with H_2SO_4 Cool to 4°C	28 days
Total Alkalinity	EPA 310.1	One 500-mL polyethylene container	Not applicable	Unpreserved Cool to 4°C	14 days
Carbonate/Bicarbonate/ Hydroxide Alkalinity	SM 2320B, SMEWW	One 500-mL polyethylene container	Not applicable	Unpreserved Cool to 4°C	14 days
Total Dissolved Solids (TDS)	EPA 160.1, MCAWW	One 500-mL polyethylene container	Not applicable	Unpreserved Cool to 4°C	7 days
Total Suspended Solids (TSS)	EPA 160.2, MCAWW	One 500-mL polyethylene container	Not applicable	Unpreserved Cool to 4°C	7 days

TABLE 2-1 (Continued)

ANALYTICAL PROTOCOLS FOR GROUNDWATER
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Analysis	Method/ Reference	Sample Volume, Container	Extra MS/MSD Volume	Preservation	Analytical Holding Time
Off-Site Laboratory Analyses – Analytes of Concern (Continued)					
Methane/Ethane/Ethene	RSK-175	Three 40-mL VOC vials	Not applicable	Sample must be collected without headspace Preserve with HCl to pH ≤ 2 and cool to 4°C	14 days (7 days if unpreserved)
Salinity	SM 2520B, SMEWW	One 500-mL polyethylene container	Not applicable	Unpreserved Cool to 4°C	28 days
Field Measurements					
Dissolved oxygen	Water quality meter[c,d]	Not applicable	Not applicable	Limit introduction of atmospheric oxygen during measurement	Analyze immediately
Oxidation-Reduction Potential	Water quality meter[c]	Not applicable	Not applicable	Time sensitive	Analyze immediately
PH	Water quality meter[c]	Not applicable	Not applicable	Time sensitive	Analyze immediately
Specific Conductance	Water quality meter[c]	Not applicable	Not applicable	Time sensitive	Analyze immediately
Temperature	Water quality meter[c]	Not applicable	Not applicable	Time sensitive	Analyze immediately
Turbidity	Water quality meter[e]	Not applicable	Not applicable	Time sensitive	Analyze immediately
Ferrous iron	Hach Method #8146, Pocket Colorimeter	One 1-L amber glass container (combined with manganese II)	Not applicable	Unpreserved with no headspace Filter if turbid Keep out of sunlight and analyze within 1 hour of collection	Analyze within one hour of collection
Manganese (II)	Hach Method #8146, Pocket Colorimeter	One 1-L amber glass container (combined with ferrous iron)	Not applicable	Unpreserved with no headspace Filter if turbid Keep out of sunlight and analyze within 1 hour of collection	Analyze within one hour of collection

TABLE 2-1 (Continued)

ANALYTICAL PROTOCOLS FOR GROUNDWATER
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Notes:

b	7 days to extraction, 40 days from extraction to analysis
a	Silica gel cleanup will typically be used during groundwater sampling activities; however, silica gel cleanup will not be used at locations with extensive historic analytical results without silica gel cleanup. This decision will be made by the project chemist on a site-by-site basis.
c	Field data to be measured with MicroPurge Flowcell 4000 or equivalent.
d	Dissolved oxygen also to be initially measured with YSI 55 meter or equivalent.
e	Turbidity data to be measured with a Horiba U-10 or equivalent.

Filtering: Dissolved metals samples will be filtered in the field with a 0.45 micron filter before preservation. Hexavalent chromium samples will be filtered in the laboratory.

ASTM	American Society for Testing and Materials
CLP	Contract laboratory program
EPA	U.S. Environmental Protection Agency
HCl	Hydrochloric acid
Hg	Mercury
HNO_3	Nitric acid
H_2SO_4	Sulfuric acid
L	Liter
MCAWW	Methods for Chemical Analysis of Water and Waste (EPA 1983)
mL	Milliliters
MS/MSD	Matrix spike/matrix spike duplicate. Identified volumes to be collected in addition to those for the original sample.
NaOH	Sodium hydroxide
PCB	Polychlorinated biphenyl
RSK	Robert S. Kerr US EPA Research Lab. 1994. SOP 175. Revision 0. August 11.
SM	Sampling method
SMEWW	Standard Methods for the Examination of Water and Wastewater
SVOC	Semivolatile organic compound
TDS	Total dissolved solids
TSS	Total suspended solids
µm	Micron
VOC	Volatile organic compound
ZnAC	Zinc acetate

<u>Source</u>: American Public Health Association (APHA). 1992. *Standard Methods for the Examination of Water and Wastewater*. 18th Edition. APHA Publication Office.

TABLE 2-2

COMPARISON OF DETECTION LIMITS AND ANALYTE SCREENING CRITERIA
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Chemical	HGAL (µg/L)[a]	Aquatic Criteria (µg/L)[b]	Federal Primary MCL (µg/L)[c]	California Primary MCL (µg/L)[d]	Project-Required Quantitation Limit (µg/L)	PRQL Below Criterion?
Metals						
Aluminum	--	--	--	**1000**	50	Yes
Antimony	**43.26**	--	6	6	5	Yes
Arsenic	27.34	**36**[g]	50	50	5	Yes
Barium	504.2	--	2000	**1000**	20	Yes
Beryllium	1.40	--	**4**	**4**	1	Yes
Cadmium	**5.08**	9.3[g]	5	5	2	Yes
Chromium	15.66	1,030[e,i]	100	**50**	5	Yes
Chromium VI	--	**50**[g]	--	--	10	Yes
Cobalt	**20.80**	**--**	--	--	5	Yes
Copper	**28.04**	3.1[g]	1300	1300	5	Yes
Lead	**14.44**	8.1[g]	15	15	1	Yes
Manganese	**8140**	--	--	--	10	Yes
Mercury	0.6	**0.94**[g]	2	2	0.1	Yes
Nickel	**96.48**	8.2[g]	--	100	20	Yes
Selenium	14.5	71[g]	**50**	**50**	40	Yes
Silver	**7.43**	0.19[q]	100	100	6	Yes
Thallium	**12.97**	213[e]	2	2	2	Yes
Zinc	75.68	**81**[g]	--	--	10	Yes
Volatile Organic Compounds						
Benzene	NA	510[e]	5	**1**	1	Yes[r]
Carbon Tetrachloride	NA	6,400[f]	5	**0.5**	0.5	Yes[r]
Chlorobenzene	NA	129[f]	100	**70**	1	Yes
Chloroform	NA	6,400[f]	**100**	**100**	1	Yes
1,2-Dibromo-3-chloropropane	NA	--	**0.2**	**0.2**	1	No[s]
1,2-Dichlorobenzene	NA	**129**[f]	600	600	1	Yes
1,3-Dichlorobenzene	NA	**129**[f]	--	--	1	Yes
1,4-Dichlorobenzene	NA	129[f]	75	**5**	1	Yes
1,1-Dichloroethane	NA	--	--	**5**	1	Yes
1,2-Dichloroethane	NA	11,300[e]	5	**0.5**	0.5	Yes[r]
1,1-Dichloroethene	NA	22,400[e]	7	**6**	1	Yes
1,2-Dichloroethene (total)	NA	**22,400**[e]	--	--	1	Yes
cis-1,2-Dichloroethene	NA	22,400[e]	70	**6**	1	Yes
trans-1,2-Dichloroethene	NA	22,400[e]	100	**10**	1	Yes
1,2-Dichloropropane	NA	3,040[f]	**5**	**5**	1	Yes
cis-1,3-Dichloropropene	NA	79[l]	--	**0.5**[l]	0.5	Yes[r]
Ethylbenzene	NA	**43**[e]	700	700	1	Yes
Methylene Chloride	NA	6,400[f]	**5**	**5**	1	Yes
1,1,2,2-Tetrachloroethane	NA	902[e]	--	**1**	1	Yes[r]
Tetrachloroethene	NA	450[f]	**5**	**5**	1	Yes
1,2,4-Trichlorobenzene	NA	129[f]	**70**	**70**	1	Yes
1,1,1-Trichloroethane	NA	3,120[e]	**200**	**200**	1	Yes
1,1,2-Trichloroethane	NA	--	**5**	**5**	1	Yes
Trichloroethene	NA	200[e]	**5**	**5**	1	Yes
Vinyl Chloride	NA	--	2	**0.5**	0.5	Yes[r]

TABLE 2-2 (Continued)

COMPARISON OF DETECTION LIMITS AND ANALYTE SCREENING CRITERIA
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Chemical	HGAL (µg/L)[a]	Aquatic Criteria (µg/L)[b]	Federal Primary MCL (µg/L)[c]	California Primary MCL (µg/L)[d]	Project-Required Quantitation Limit (µg/L)	PRQL Below Criterion?
Semivolatile Organic Compounds						
Bis(2-ethylhexyl)phthalate	NA	--	6	**4**	5	No[s]
2-Chloronaphthalene	NA	**0.75**[e]	--	--	5	No[s]
2,4-Dinitrotoluene	NA	**59**[e]	--	--	5	Yes
Hexachloroethane	NA	**94**[e]	--	--	5	Yes
Pentachlorophenol	NA	7.9[g]	**1**	**1**	5	No[s]
Phenol	NA	**580**[e]	--	--	5	Yes
Polynuclear Aromatic Hydrocarbons						
Benzo(a)pyrene	NA	30[e,k]	**0.2**	**0.2**	0.1	Yes
Chrysene	NA	**30**[e,k]	--	--	5	Yes
Fluoranthene	NA	**16**[f]	--	--	5	Yes
Fluorene	NA	**30**[e,k]	--	--	5	Yes
2-Methylnaphthalene	NA	**30**[e,k]	--	--	5	Yes
Naphthalene	NA	**235**[e]	--	--	5	Yes
Phenanthrene	NA	**30**[e,k]	--	--	5	Yes
Polychlorinated Biphenyls						
Aroclor-1248	NA	**0.03**[g,h]	0.5[h]	0.5[h]	0.2	No[s]
Aroclor-1254	NA	**0.03**[g,h]	0.5[h]	0.5[h]	0.2	No[s]
Aroclor-1260	NA	**0.03**[g,h]	0.5[h]	0.5[h]	0.2	No[s]
Pesticides						
Chlordane (alpha and gamma)	NA	**0.004**[f,j]	2[j]	0.1[j]	0.01	No[s]
4,4'-DDT	NA	**0.001**[g]	--	--	0.02	No[s]
Dieldrin	NA	**0.0019**[g]	--	--	0.02	No[s]
Endosulfan II	NA	**0.0087**[g]	--	--	0.02	No[s]
Endrin	NA	**0.0023**[g]	2	2	0.02	No[s]
Heptachlor	NA	**0.0036**[g]	0.4	0.01	0.01	No[s]
Heptachlor epoxide	NA	**0.0036**[g]	0.2	0.01	0.01	No[s]
Organophosphorus Compounds						
Chlorpyrifos	NA	**0.0056**[g]	--	--	0.2	No[s]
Diazinon	NA	--	--	--	0.2	NA
Dimethioate	NA	--	--	--	0.2	NA
Disulfoton	NA	--	--	--	0.2	NA
Ethion	NA	--	--	--	0.2	NA
Famphur	NA	--	--	--	0.2	NA
Malathion	NA	--	--	--	0.2	NA
Parathion-ethyl	NA	--	--	--	0.2	NA
Parathion-methyl	NA	--	--	--	0.2	NA
Phorate	NA	--	--	--	0.2	NA

TABLE 2-2 (Continued)

**COMPARISON OF DETECTION LIMITS AND ANALYTE SCREENING CRITERIA
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA**

Chemical	HGAL (µg/L)[a]	Aquatic Criteria (µg/L)[b]	Federal Primary MCL (µg/L)[c]	California Primary MCL (µg/L)[d]	Project-Required Quantitation Limit (µg/L)	PRQL Below Criterion?
Anions						
Bicarbonate	NA	--	--	--	20,000 µg/L as calcium carbonate	NA
Chloride	NA	--	--	--	500	NA
Nitrate-N	NA	--	10,000	45,000	100	NA
Nitrite-N	NA	--	1,000	1,000	100	NA
Sulfate	NA	--	500,000	--	500	NA
Sulfide	NA	--	--	--	40	NA
Radioactivity						
Gross alpha radioactivity	NA	--	**15 pCi/L**[m]	**15 pCi/L**[m]	5 pCi/L	Yes
Gross beta radioactivity	NA	--	4 mrem/yr	**15 pCi/L**[m]	5 pCi/L	Yes
Americium-241	NA	--	**NA**[n]	--	0.1 pCi/L	NA
Cesium-137	NA	--	**80 pCi/L**[n]	--	10 pCi/L	Yes
Coballt-60	NA	--	**240 pCi/L**[n]	--	10 pCi/L	Yes
Europium-152	NA	--	**10,000 pCi/L**[o]	--	90 pCi/L	Yes
Europium-154	NA	--	**7,000 pCi/L**[o]	--	90 pCi/L	Yes
Isotopic Uranium	NA	--	**24 pCi/L**[n]	--	0.2 pCi/L	Yes
Potassium-40	NA	--	**NA**[n]	--	10 pCi/L	NA
Radium 226	NA	--	**5 pCi/L**[p]	**5 pCi/L**[p]	1 pCi/L	Yes
Radium 228	NA	--	**5 pCi/L**[p]	**5 pCi/L**[p]	1 pCi/L	Yes
Strontium-90	NA	--	**8 pCi/L**	--	1 pCi/L	Yes
Tritium	NA	--	--	**20,000 pCi/L**	400 pCi/L	Yes
Other						
Ammonia Nitrogen	NA	**35**	--	--	50	No[s]
Cyanide	NA	**1**[g]	200	200	10	No[s]
Fluoride	NA	--	4,000	**2,000**	500	Yes
Total Kjeldhal Nitrogen	NA	--	--	--	1,000	NA
Total Dissolved Solids	NA	--	--	--	20,000	NA
Total Suspended Solids	NA	--	--	--	20,000	NA

TABLE 2-2 (Continued)

COMPARISON OF DETECTION LIMITS AND ANALYTE SCREENING CRITERIA
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Notes: Historical concentrations of chemicals included on this table exceeded one or more regulatory screening criterion in groundwater at Parcels C, D, or E.

Values in bold text are selected as the evaluation criteria.

a PRC Environmental Management, Inc. 1996. "Estimation of Hunters Point Shipyard Groundwater Ambient Levels Technical Memorandum." September 16.

b Aquatic criteria shown are the more stringent of the national recommended criteria for protection of saltwater aquatic life and the California toxics rule criteria for protection of saltwater aquatic life in enclosed bays and estuaries (continuous concentration [4-day average]). If neither of these values are available, the Environmental Protection Agency (EPA) chronic toxicity level is shown. If none of the above criteria are available, one-tenth of the EPA acute toxicity level or instantaneous maximum is shown. The source of these criteria is the August 2000 revision of "A Compilation of Water Quality Goals" prepared by the California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region.

c EPA. 2001. "Current Drinking Water Standards." Office of Groundwater and Drinking Water. Website accessed on April 16, 2001. On-line address is http://www.epa.gov/safewater/mcl.html

d California Department of Health Services. 2001. "Drinking Water Standards." Website accessed on April 9, 2001. On-line address is http://www.dhs.cahwnet.gov/org/ps/ddwem/chemicals/mcl/primarymcls.htm

e One-tenth of EPA acute toxicity (lowest observed effect) level for saltwater aquatic life protection, see note b.

f EPA chronic toxicity (lowest observed effect) level for saltwater aquatic life protection, see note b.

g EPA recommended criteria, continuous concentration (4-day average) for saltwater aquatic life protection, see note b.

h Criterion is for total polychlorinated biphenyls (PCBs), but also applies to Aroclor-1260.

i Criterion is for chromium III; no criterion exists for total chromium.

j Criterion is for total chlordane, which includes both alpha and gamma isomers.

k Criterion is for polynuclear aromatic hydrocarbons as a class of compounds.

l Criterion is for the sum of cis- and trans 1,3-dichloropropene; no criterion is available for the individual isomers.

m Including Radium-226 but excluding Radon and Uranium.

n Values reported as project-required reporting limits (PRRLs) in this table represent the regulatory limits for potable groundwater per 40 Code of Federal Regulations (CFR) 141.15/16 and were obtained from the Radiological Site Inspection Report for the Decommissioning of Mare Island Naval Shipyard (Supervisor of Shipbuilding, Conversion, and Repair, Portsmouth, Virginia [SSPORTS] 1997).

o Values reported per Title 10 CFR Part 20, Appendix B.

p Criterion is for a combined level for radium-226 and radium-228.

q One-tenth of EPA recommended criteria, instantaneous maximum for saltwater aquatic life protection, see note b.

r The listed PRQL reflects the maximum sensitivity of current, routinely used analytical methods and is equal to the applicable criterion; since the method detection limit for each analyte is at or below the PRQL, detected or nondetected results reported at the PRQL will meet the project requirements.

s The listed PRQL reflects the maximum sensitivity of current, routinely used analytical methods. The listed PRQL will be used as the project screening criteria unless reasonable grounds are established for pursuing non-routine methods.

-- Criterion not available
DDT Dichlorodiphenyltrichloroethane
EPA U.S. Environmental Protection Agency
HGAL Hunters Point groundwater ambient level; see note a
LRL Laboratory reporting limit
MCL Maximum contaminant level
mrem/yr Millirems per year
µg/L Microgram per liter
NA Not applicable
pCi/L Picocuries per liter
PRQL Project-required quantitation limit

APPENDIX 3

PRECISION AND ACCURACY GOALS

TABLE 3-1

VOLATILE ORGANIC COMPOUNDS (EPA 8260B)
PRECISION AND ACCURACY GOALS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Laboratory and Matrix Spike Limits

Fraction	Spike Compound	% Recovery	RPD
VOC	1,1-Dichloroethene	61-145	14
VOC	Trichlorethene	71-120	14
VOC	Chlorobenzene	75-130	13
VOC	Toluene	76-125	13
VOC	Benzene	76-127	11

Surrogate Recovery Limits

Fraction	Surrogate Compound	% Recovery
VOC	Toluene-d_8	88-110
VOC	4-Bromofluorobenzene	86-115
VOC	1,2-Dichloroethane-d_4	76-114

Notes:

d Deuterium
EPA U.S. Environmental Protection Agency
RPD Relative percent difference
VOC Volatile organic compound

TABLE 3-2

SEMIVOLATILE ORGANIC COMPOUNDS (EPA 8270C)
PRECISION AND ACCURACY GOALS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Laboratory and Matrix Spike Limits

Fraction	Spike Compound	% Recovery	RPD
Base/Neutral	1,2,4-Trichlorobenzene	39-98	28
Base/Neutral	Acenaphthene	46-118	31
Base/Neutral	2,4-Dinitrotoluene	24-96	38
Base/Neutral	Pyrene	26-127	31
Base/Neutral	N-Nitroso-di-n-propylamine	41-116	38
Base/Neutral	1,4-Dichlorobenzene	36-97	28
Acid	Pentachlorophenol	9-103	50
Acid	Phenol	12-110	42
Acid	2-Chlorophenol	27-123	40
Acid	4-Chloro-3-methylphenol	23-97	42
Acid	4-Nitrophenol	10-80	50

Surrogate Recovery Limits

Fraction	Surrogate Compound	% Recovery
Base/Neutral	Nitrobenzene-d_5	35-114
Base/Neutral	2-Fluorobiphenyl	43-116
Base/Neutral	p-Terphenyl-d_{14}	33-141
Base/Neutral	1,2-Dichlorobenzene-d_4	16-110
Acid	Phenol-d_5	10-110
Acid	2-Fluorophenol	21-110
Acid	2,4,6-Tribromophenol	10-123
Acid	2-Chlorophenol-d_4	33-110

Notes:

d	Deuterium
EPA	U.S. Environmental Protection Agency
RPD	Relative percent difference

TABLE 3-3

PESTICIDES AND POLYCHLORINATED BIPHENYLS (EPA 8081/8082) PRECISION AND ACCURACY GOALS PHASE III GROUNDWATER DATA GAPS INVESTIGATION HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Laboratory and Matrix Spike Limits

Fraction	Spike Compound	% Recovery	RPD
Pesticide/PCB	gamma-BHC	56-123	15
Pesticide/PCB	Heptachlor	40-131	20
Pesticide/PCB	Aldrin	40-120	22
Pesticide/PCB	Dieldrin	52-126	18
Pesticide/PCB	Endrin	56-121	21
Pesticide/PCB	4,4'-DDT	38-127	27
Pesticide/PCB	Aroclor-1260	50-150	50

Surrogate Recovery Limits

Fraction	Surrogate Compound	% Recovery
Pesticide/PCB	Tetrachloro-m-xylene	30-150
Pesticide/PCB	Decachlorobiphenyl	30-150

Notes:

BHC	Benzene hexachloride
DDT	Dichlorodiphenyltrichloroethane
EPA	U.S. Environmental Protection Agency
PCB	Polychlorinated biphenyl
RPD	Relative Percent difference

TABLE 3-4

INORGANIC ANALYSES
PRECISION AND ACCURACY GOALS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Analyses	Method	% Recovery[a]	RPD[b]
Alkalinity	SM 2320, SMEWW	NA	10
Ammonia Nitrogen	EPA 350.1	75-125	20
Anions: Chloride, Nitrate-N, Nitrite-N, and Sulfate	EPA 300.1 EPA 353.2	75-125	20
Cyanide	EPA 9010	75-125	20
Fluoride	EPA 340.2	75-125	20
Hexavalent Chromium	EPA 7196A	75-125	20
Metals, Dissolved	CLP SOW	75-125	20
Sulfide	EPA 376.2	75-125	20
Total Kjeldahl Nitrogen	EPA 351.4	75-125	20
Total Dissolved Solids	EPA 160.1, MCAWW	75-125	20
Total Suspended Solids	EPA 160.2, MCAWW	75-125	20

Notes:

a Percent recovery control limit is based on spiked sample
b Relative percent difference control limit is based on duplicate sample

CLP Contract Laboratory Program
EPA U.S. Environmental Protection Agency
MCAWW Methods for Chemical Analysis of Water and Wastes
NA Not applicable
RPD Relative percent difference
SM Sampling method
SMEWW Standard Methods for the Examination of Water and Wastewater
SOW Statement of work

Source: American Public Health Association (APHA). 1992. *Standard Methods for the Examination of Water and Wastewater*. 18th Edition. APHA Publication Office.

U.S. Environmental Protection Agency (EPA). 1983. “Methods for Chemical Analysis of Water and Waste.” EPA-600/4-79-020. March.

TABLE 3-5

RADIOACTIVITY ANALYSES
PRECISION AND ACCURACY GOALS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Analyses	Method	% Recovery	Control Limit
Gross Alpha and Gross Beta Radioactivity	EPA Method 9310	70-130	2.13
Radium-226	EPA Method 9315	75-125	2.13
Radium-228	EPA Method 9320	70-130	2.13
Americium-241	ASTM D3927-90M	79-118	2.13
Cesium-137	EPA 901.1M, MCAWW	85-115	2.13
Cobalt-60	EPA 901.1M, MCAWW	85-115	2.13
Europium-152	EPA 901.1 m, MCAWW	85-115	2.13
Europium-154	EPA 901.1 m, MCAWW	85-115	2.13
Potassium-40	EPA 901.1M, MCAWW	NA	2.13
Tritium	EPA 906	85-115	2.13
Isotopic Uranium	ASTM D3927-90M	82-122	2.13
Strontium-90	ASTM D5811-95M	75-125	2.13

Notes:

ASTM American Society for Testing and Materials
EPA U.S. Environmental Protection Agency
MCAWW Methods for Chemical Analysis of Water and Wastes
NA Not applicable

Source: U.S. Environmental Protection Agency (EPA). 1983. “Methods for Chemical Analysis of Water and Waste.” EPA-600/4-79-020. March.

TABLE 3-6

ORGANOPHOSPHORUS COMPOUNDS (EPA 8141A)
PRECISION AND ACCURACY GOALS
PHASE III GROUNDWATER DATA GAPS INVESTIGATION
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

Laboratory and Matrix Spike Limits

Fraction	Spike Compound	% Recovery	RPD
Organophosphate	Chlorpyrifos	50-150	50
Organophosphate	Diazinon	50-150	50
Organophosphate	Dimethioate	50-150	50
Organophosphate	Disulfoton	50-150	50
Organophosphate	Ethion	50-150	50
Organophosphate	Famphur	50-150	50
Organophosphate	Malathion	50-150	50
Organophosphate	Parathion	50-150	50
Organophosphate	Parathion-ethyl	50-150	50
Organophosphate	Parathion-methyl	50-150	50
Organophosphate	Phorate	50-150	50

Surrogate Recovery Limits

Fraction	Surrogate Compound	% Recovery
Organophosphate	Tributylphosphate	60-140
Organophosphate	Triphenylphosphate	60-140

Notes:

EPA U.S. Environmental Protection Agency
RPD Relative Percent difference

APPENDIX 4

EVALUATION OF EXISTING DATA FOR RADIONUCLIDES AND RADIOLOGICAL INDICATORS IN SHALLOW GROUNDWATER AT HUNTERS POINT SHIPYARD

CONTENTS

1.0 INTRODUCTION

Existing validated analytical data for radionuclides and radiological indicators (that is, gross alpha and gross beta) in groundwater samples collected from Hunters Point Shipyard (HPS) were compiled and statistically evaluated to assess whether groundwater appeared to be contaminated with site-related radioactive constituents. Data were collected during two major sampling events, from October 24, 1990, through May 8, 1992, and from March 6, 2001, to April 24, 2001 (referred to as the "old" and "new" data). The old data were collected under earlier investigations in the Installation Restoration (IR) Program, whereas the new data were collected for remedial investigations in Parcel E at HPS. In addition, the old data for groundwater samples from HPS consist solely of results for gross alpha and gross beta, whereas the new data also include radium-226 and radium-228.

There are also limited data for county water supplies; these data range in age from June 11, 1983, to March 14, 2001, and include data for gross alpha (n = 1,312), gross beta (n = 619), radium-226 (n = 149), and radium-228 (n = 136). These results are also presented here to provide regional background levels. Unfortunately, no values are provided for the analytical uncertainty, so the data-age factor cannot be evaluated against the magnitude of analytical uncertainty.

Although all HPS data were validated, the older data (1990 to 1992) exhibit greater analytical uncertainties and a wider range of activities for gross alpha and gross beta measurements than do the newer data. Another difference is that the older data represent a mix of samples from monitoring wells and "grab groundwater" (Hydropunch) samples, whereas the newer data are strictly for samples collected from monitoring wells.

Summary statistics and statistical plots were generated for all data, and include box-and-whisker plots, normal probability plots, and correlation plots of the data. Selected plots and results of the data evaluation are provided in this appendix.

1.1 OLDER DATA VERSUS NEWER DATA FOR HUNTERS POINT SHIPYARD

One line of analysis evaluated the HPS data according to the year the samples were collected. As shown in the box-and-whisker plots grouped by year, the older data show a much wider range of activities that result from large analytical uncertainties reported for the analyses of gross alpha and gross beta from 1990 through 1992 (Figure 4-1). The analytical uncertainties reported for the older data suggest that they should not be included in the final analysis. The uncertainties for the data collected in 2001 are much smaller than for the data for 1990 to 1992, and should be taken as a more reliable reflection of water quality with respect to radionuclides and radiological indicators.

1.2 CORRELATION ANALYSIS

The newer data for samples collected from Parcel E in 2001 were reviewed for overall distribution and for the range of values reported for each IR site. Data were available for gross alpha, gross beta, radium-226, and radium-228. Correlation analysis showed no significant relationships between the data for radium-226 (an alpha emitter) and gross alpha, or between radium-228 (a beta emitter) and gross beta. There was, however, a reasonably good correlation ($r = 0.93$) between data for the two radium isotopes (Figure 4-2).

1.3 DATA DISTRIBUTIONS: HETEROGENEITY

When the data for samples collected in 2001 were combined for all sites, none of the analytes exhibited a normal distribution (that is, p-values for the Shapiro Wilk W test were less than 0.05) (Figure 4-3) However, if the data are grouped by IR site, the results for some sites where an adequate number of samples was collected appear to better fit a normal distribution (Figures 4-4 through 4-7). The poor fit to a normal distribution may be a consequence of spatial heterogeneity within groundwater at HPS; this possibility will be better evaluated with the new data that will be collected for the current study.

1.4 REGIONAL BACKGROUND DATA FOR RADIONUCLIDES

Data were also available for radium species and radiological indicators in county water supplies. The box-and-whisker plots show the ranges of activities for Alameda, Contra Costa, San Francisco, and San Mateo county water supplies (Figure 4-8). Data for water in Contra Costa County exhibited a few high values for gross beta (two results greater than 50 picocuries per liter [pCi/L]) and one high value for radium-228 (one result greater than 3.0 pCi/L). These data provide regional background levels for radionuclide activities and establish a reality-based scale for at least a qualitative comparison with the data for HPS. There appear to be infrequent detections of higher activity; whether these detections represent true conditions or erratic readings is not known.

2.0 SUMMARY

Existing validated data for radionuclide activities in shallow groundwater at HPS are ambiguous because most are for radiological indicators rather than for specific radionuclides. The highest values are reported in 1990 and 1991 data for gross alpha and gross beta; however, closer inspection indicates high-value nondetections and large uncertainties for these data. It is concluded that only the newer data should be used in any statistical comparisons that may be conducted.

Other elements of uncertainty for evaluating site data are the local background levels for specific radionuclides and the background level for gross beta activities in seawater. The latter is a concern because naturally occurring potassium-40 averages about 300 pCi/L in sea water. Analysis of groundwater and sea water for specific radionuclides will minimize the ambiguity caused by nonspecific analyses and background radioactivity.

FIGURE 4-1

BOX AND WHISKER PLOTS COMPARING NEWER AND OLDER DATA SETS
DATA GAPS SAMPLING FOR RADIONUCLIDES IN GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

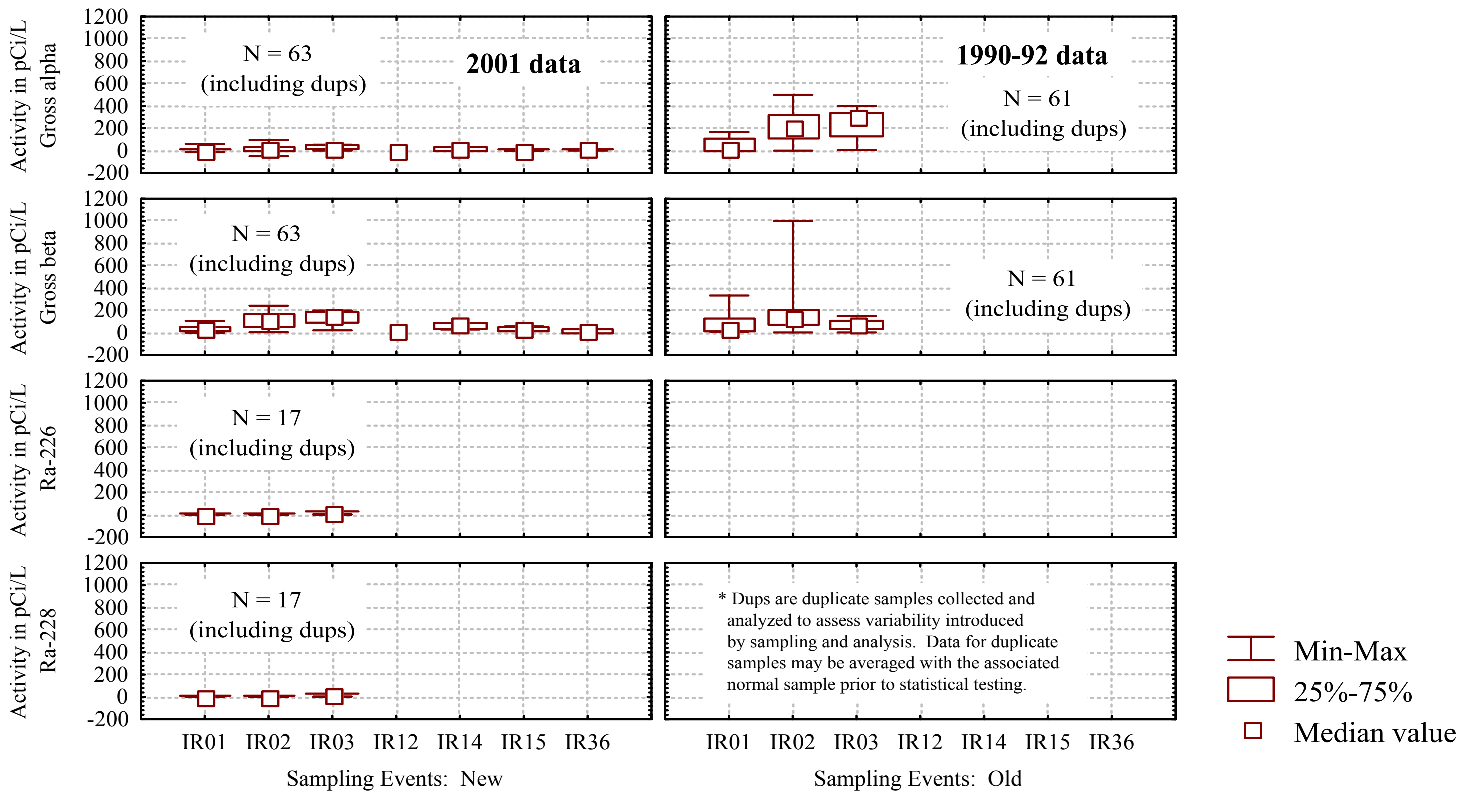


FIGURE 4-2

CORRELATIONS USING VALIDATED DATA FOR GROUNDWATER DATA GAPS SAMPLING FOR RADIONUCLIDES IN GROUNDWATER HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

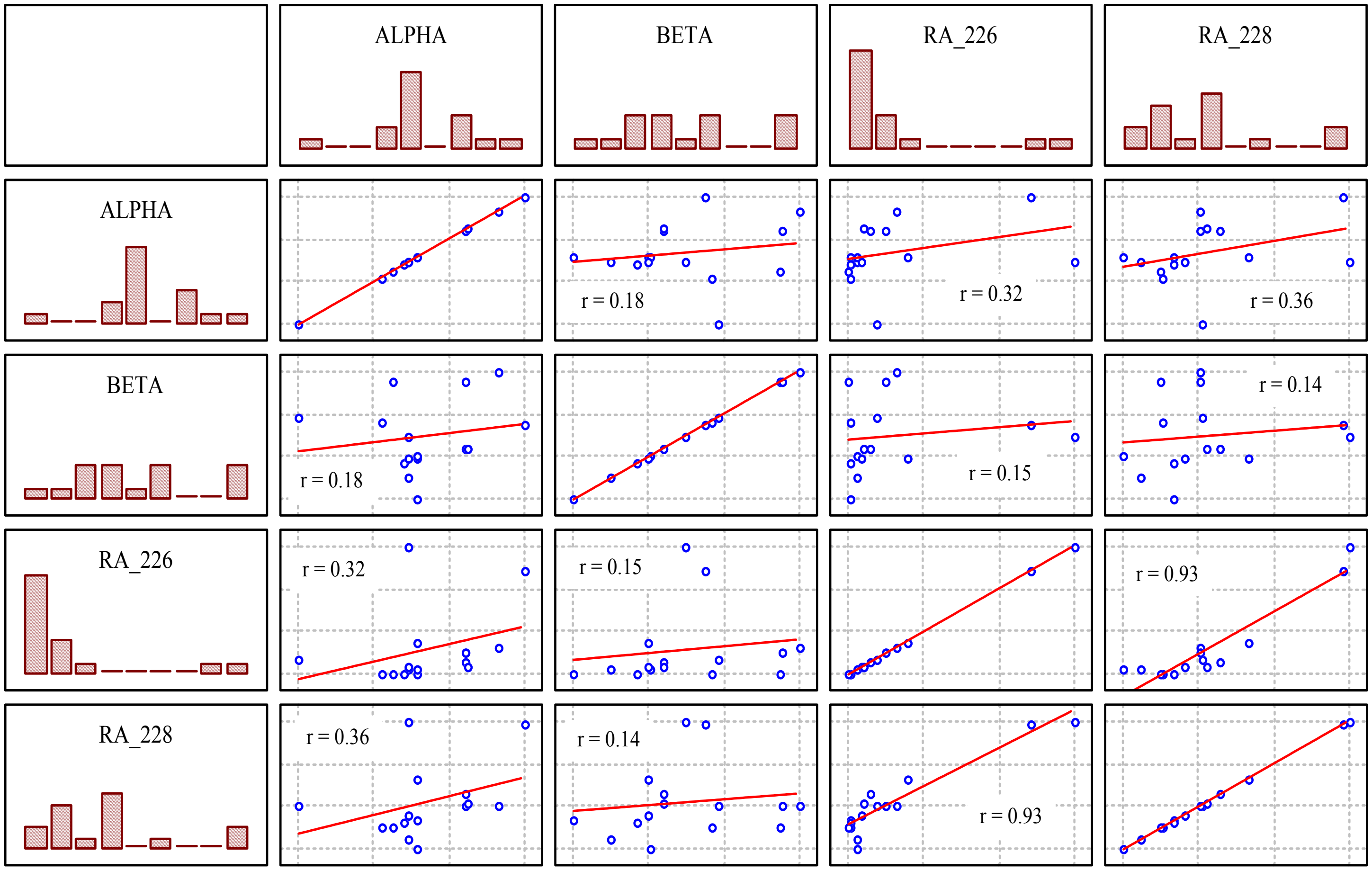
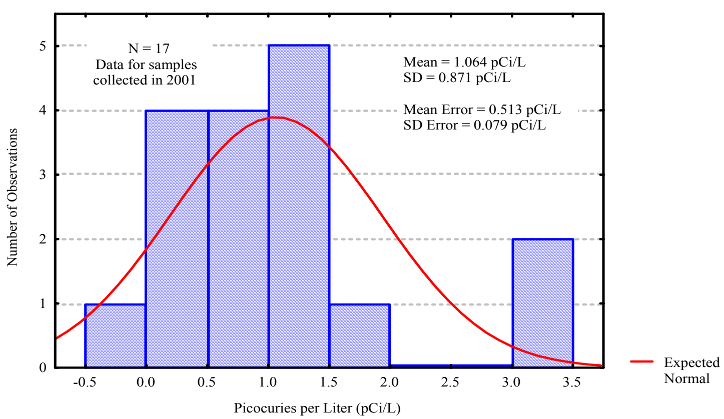


FIGURE 4-3

FREQUENCY PLOTS SHOWING VALIDATED DATA FOR GROUNDWATER DATA GAPS SAMPLING FOR RADIONUCLIDES IN GROUNDWATER HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

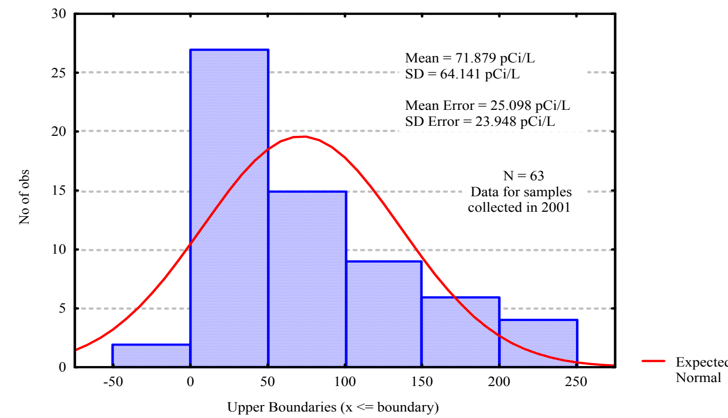
Radium-228 Activity as Measured in Groundwater Samples from Hunters Point

Shapiro-Wilk W=.82785, p<.0050 (Non-normal Distribution Indicated)



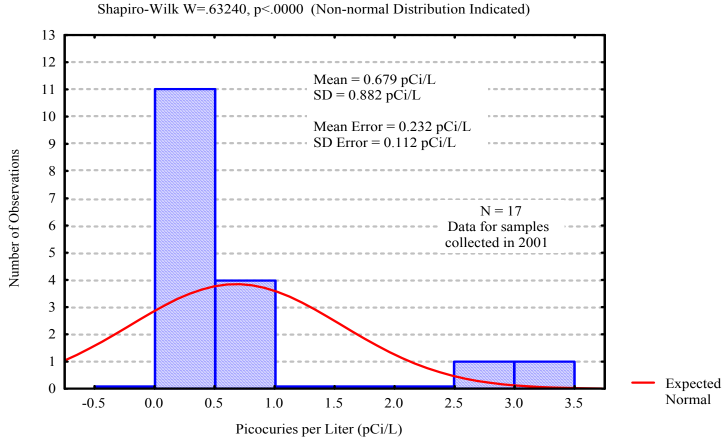
Gross Beta Activity as Measured in Groundwater Samples from Hunters Point

Shapiro-Wilk W=.88675, p<.0000 (Non-normal Distribution Indicated)



Radium-226 Activity as Measured in Groundwater Samples from Hunters Point

Shapiro-Wilk W=.63240, p<.0000 (Non-normal Distribution Indicated)



Gross Alpha Activity as Measured in Groundwater Samples from Hunters Point

Shapiro-Wilk W=.80585, p<.0000 (Non-normal Distribution Indicated)

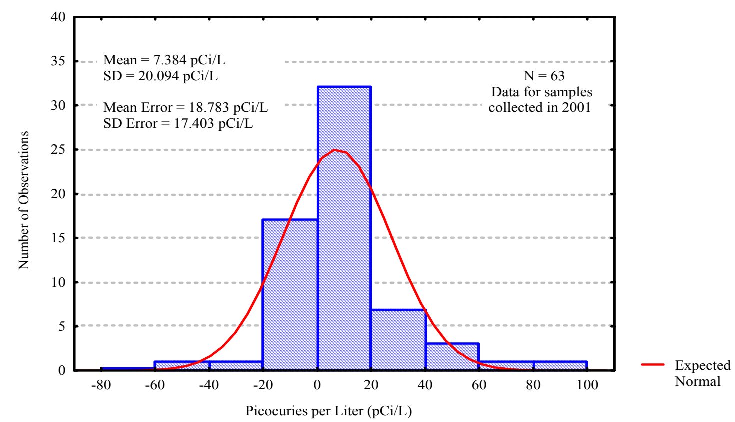


FIGURE 4-4

NORMAL PROBABILITY PLOTS OF GROSS ALPHA ACTIVITY
DATA GAPS SAMPLING FOR RADIONUCLIDES IN GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

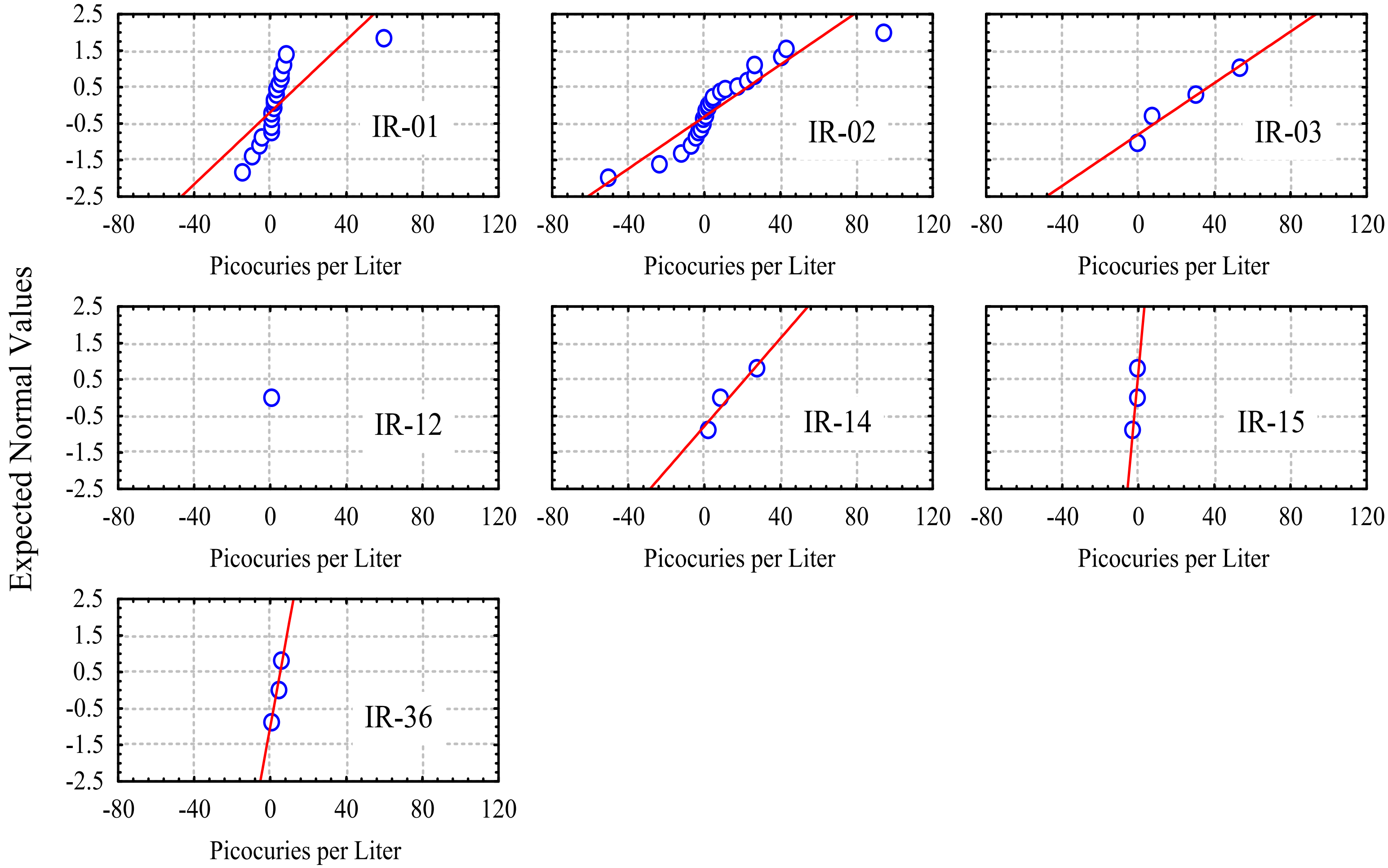


FIGURE 4-5

NORMAL PROBABILITY PLOTS OF GROSS BETA ACTIVITY
DATA GAPS SAMPLING FOR RADIONUCLIDES IN GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

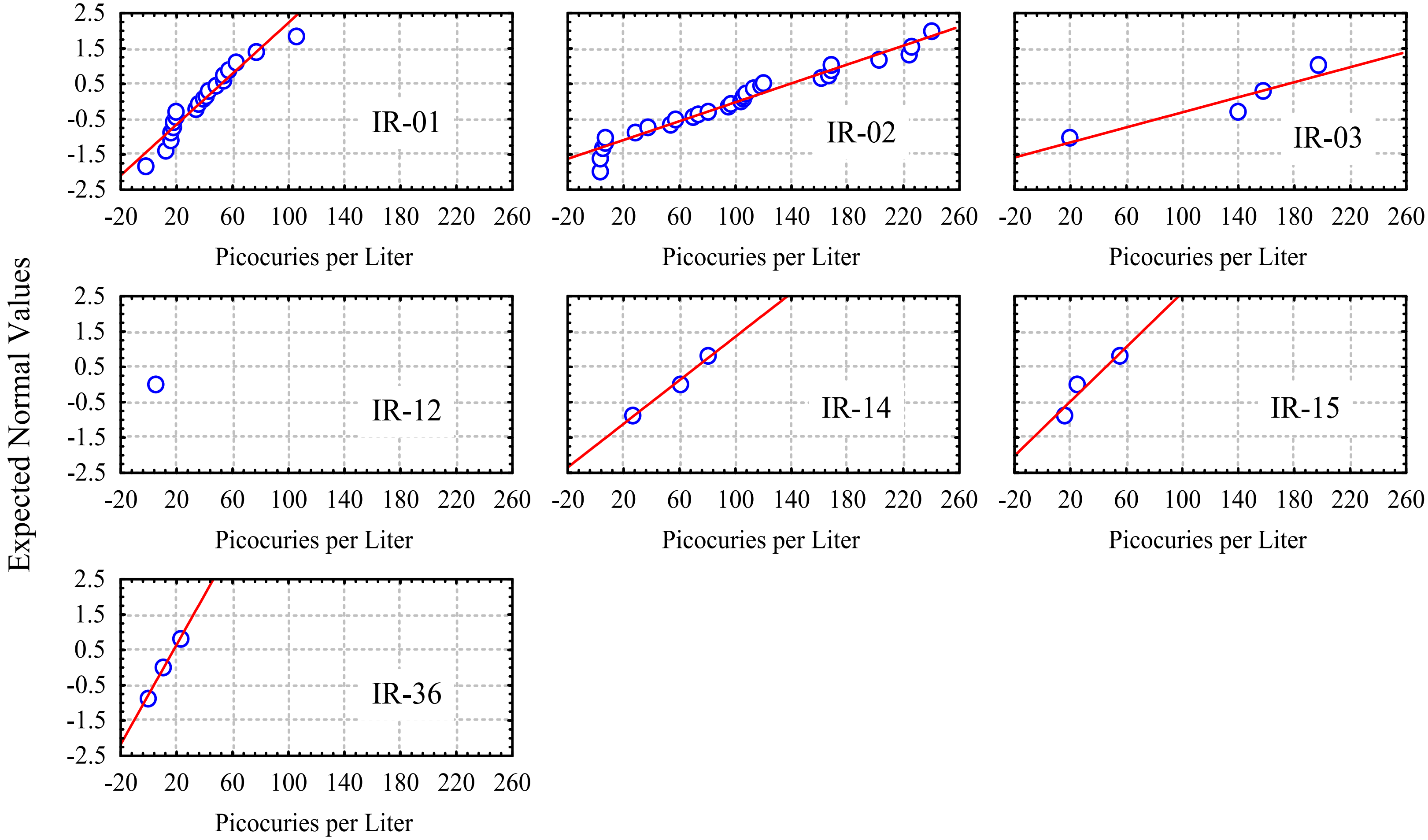


FIGURE 4-6

**NORMAL PROBABILITY PLOTS OF RADIUM-226 ACTIVITY
DATA GAPS SAMPLING FOR RADIONUCLIDES IN GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA**

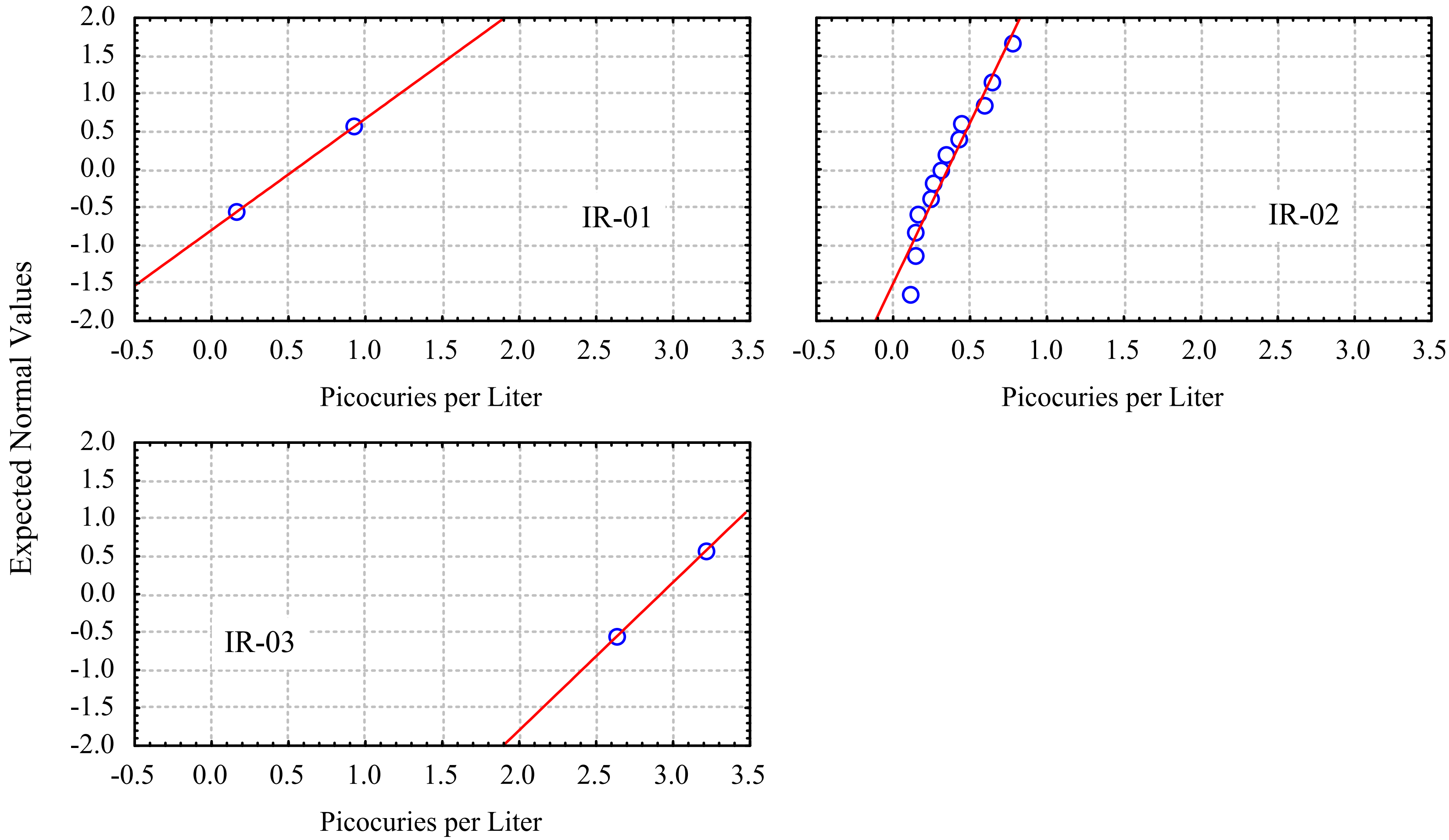


FIGURE 4-7

NORMAL PROBABILITY PLOTS OF RADIUM-228 ACTIVITY
DATA GAPS SAMPLING FOR RADIONUCLIDES IN GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA

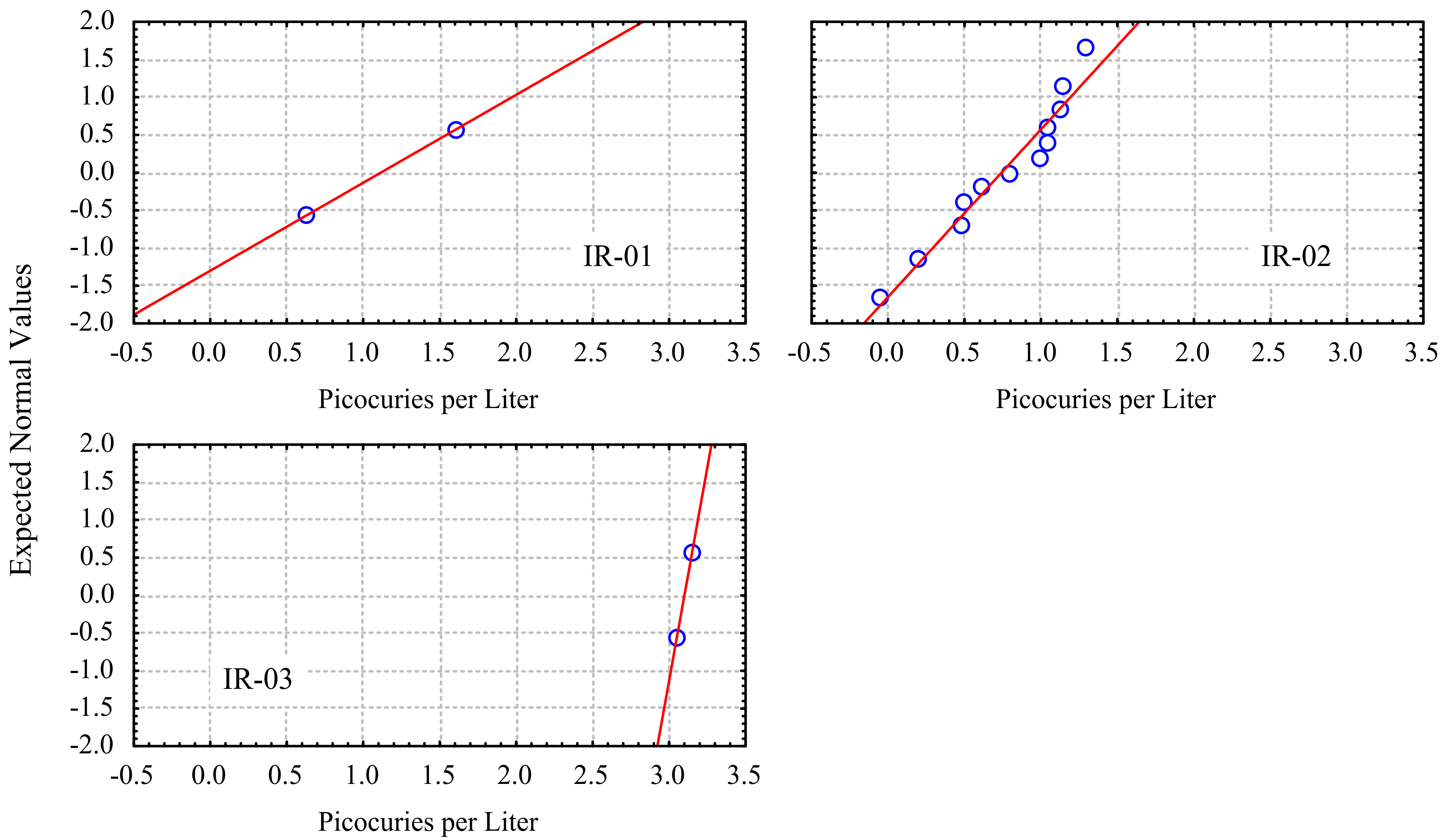
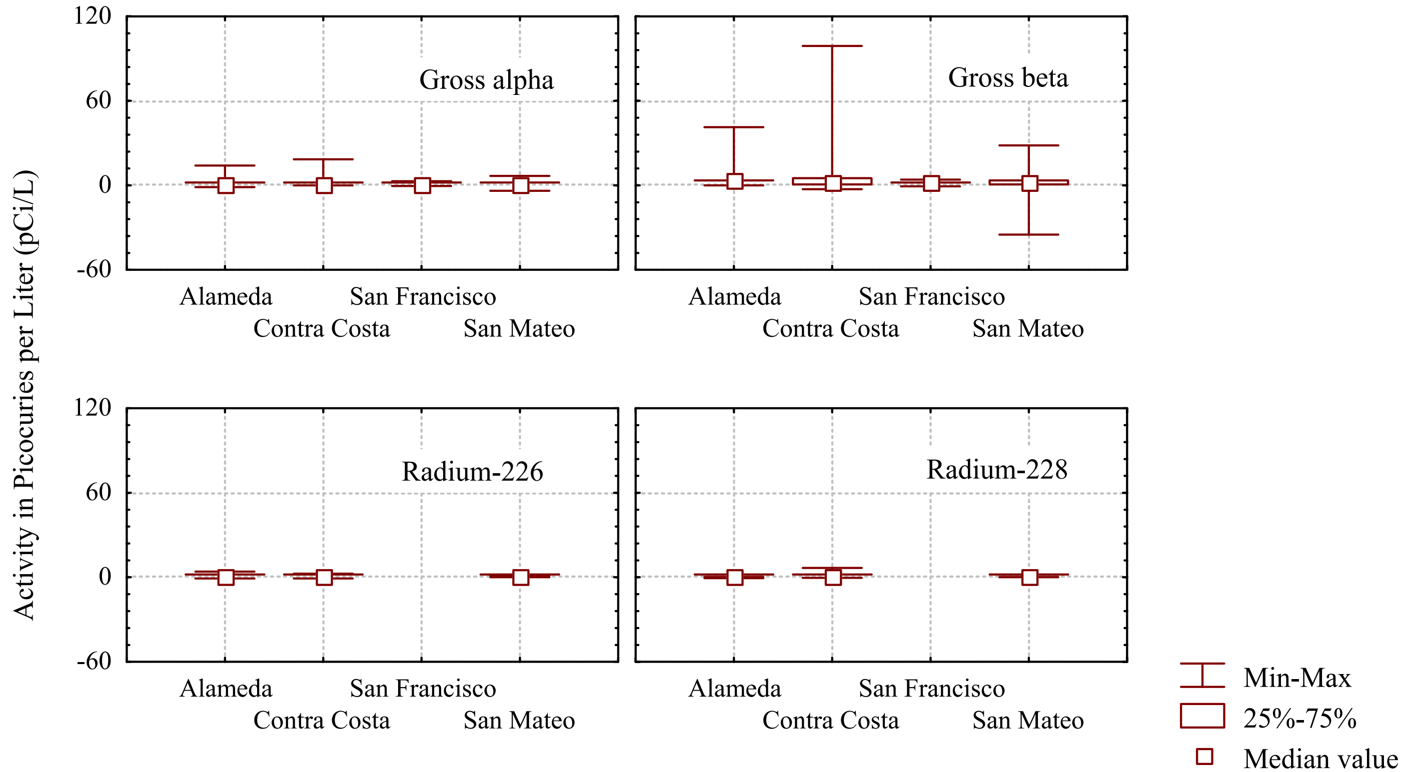


FIGURE 4-8

BOX AND WHISKER PLOTS FOR RADIONUCLIDES AND RADIOLOGICAL INDICATORS
DATA GAPS SAMPLING FOR RADIONUCLIDES IN GROUNDWATER
HUNTERS POINT SHIPYARD, SAN FRANCISCO, CALIFORNIA



APPENDIX 5

NATURALLY OCCURRING AND ANTHROPOGENIC RADIONUCLIDES IN ENVIRONMENTAL MEDIA

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Table

ABBREVIATIONS AND ACRONYMS

Ci	Curie
HPS	Hunters Point Shipyard
NRDL	Naval Radiological Defense Laboratory
pCi	Picocurie
pCi/g	Picocurie per gram
pCi/L	Picocurie per liter
TU	Tritium unit

1.0 INTRODUCTION

This appendix provides a brief overview of radioactivity and descriptions of specific radionuclides that will be analyzed for this data gap study of radionuclides in shallow groundwater at Hunters Point Shipyard (HPS). Radionuclides occur naturally throughout the environment because (1) they are primordial species with long half lives and have not yet completely decayed since they were formed; (2) they are the progeny of long-lived primordial species; (3) they are produced by nuclear reactions that occur in nature (for example, cosmic-ray bombardment); or (4) they are related to widespread radioactive fallout from atmospheric tests of nuclear weapons and nuclear releases such as those at Chernobyl.

1.1 RADIONUCLIDES AND RADIOACTIVITY

Radionuclides are characterized by the release of energy and energetic particles by changes that occur within the atomic or nuclear structure. The three principal modes of radioactive decay include alpha radiation (emissions of positively charged helium nuclei), beta radiation (emissions of electrons or positrons), and gamma radiation (emissions of high-energy electromagnetic waves, similar to x-rays). Radionuclides are isotopes of elements that emit energy by one or more forms of these decay mechanisms. The geochemical behavior of these elements can differ greatly with respect to solubility and mobility.

The abundances of radionuclides are typically expressed in terms of the rate of radioactive disintegration (that is, activity). One curie (Ci) is defined as 3.7×10^{10} disintegrations per second, which is the activity of one gram of radium in equilibrium with its daughter products (Hem 1992). This number is large, so radionuclide data generally are reported in picocuries (pCi) (10^{-12} Ci, or pCi). Because radioactivity is a matter of degree (that is, all matter is radioactive to some extent), instruments calibrated against a background level may produce negative analytical results that are part of the "noise" in the analysis. Descriptive summary statistics for radionuclides are calculated using actual reported values rather than substituted values to avoid severe biases in the parameter estimates.

1.2 NATURALLY OCCURRING RADIONUCLIDES

Naturally occurring radionuclides are present in the San Francisco Bay area. Examples of naturally occurring radionuclides include actinium-228, beryllium-7, bismuth-214, lead-212, lead-214, potassium-40, radium-224, radium-226, radium-228, thallium-208, thorium-228, thorium-230, thorium-232, thorium-234, uranium-234, uranium-235, and uranium-238. Several naturally occurring, long-lived radionuclides produce long decay chains of radionuclides en route to forming a stable end product (Table 5-1). Uranium-238, thorium-232, uranium-235, and potassium-40 are the progenitors for many of the naturally occurring radionuclides discussed below. The main isotopes of concern at HPS that occur naturally include europium, radium-226, radium-228, potassium-40, and the uranium isotopes and any daughter products. Anthropogenic species of interest include americium-241, cesium-137, cobalt-60, europium-152 and -154, and strontium-90. Tritium occurs naturally and has a worldwide background level from atmospheric testing of nuclear bombs.

Europium

Europium is part of the lanthanide series of rare earth elements. Europium-151 and europium-153 are the stable and primary isotopes of europium and together account for nearly 100 percent of the element. Europium has been identified in the sun and some stars by spectroscopy. Europium oxides are found in minerals (for example, monazite) with the other rare earth elements. Its physical properties are like those of the other members of the lanthanide series, but many of its chemical properties are more like those of calcium. Europium is a good neutron absorber.

The manmade isotopes europium-152 and europium-154 are beta emitters, with half lives of 13.48 years (europium-152) and 8.59 years (europium-154). Because europium isotopes were detected in soil samples collected near the consolidation area for radioactive wastes (near Building 707), samples of groundwater will also be analyzed for europium isotopes.

Potassium-40

Potassium-40 is a naturally occurring, beta-emitting radionuclide with a long half-life (1.27×10^9 years). Potassium-40 constitutes 0.0118 percent of naturally occurring potassium, which is a monovalent alkali metal that is found in feldspars, clays, micas, and other common rock-forming minerals and weathering products. It also forms soluble salts and is present in seawater, with potassium-40 averaging about 300 pCi per liter (pCi/L) of sea water (U.S. Army Center for Health Promotion and Preventive Medicine 1999).

TABLE 5-1

DATA GAPS SAMPLING FOR RADIONUCLIDES IN GROUNDWATER RADIOACTIVE DECAY CHAINS FOR URANIUM-238 AND THORIUM-232[a]

Most Abundant Uranium Isotope (U-238)	**Decay**	**Most Abundant Thorium Isotope (Th-232)**
Uranium-238 (4.51×10^9 years) α Thorium-234 (24.1 days) β Palladium-234 (6.7 hours) β Uranium-234 (2.48×10^5 years) α Thorium-230 (7.52×10^4 years) α Radium-226 (1,622 years) α Radon-222 (3.825 days) α Polonium-218 (3.05 minutes) α Lead-214 (26.8 minutes) β Bismuth-214 (19.7 minutes) β Polonium-214 (0.00016 seconds) α Lead-210 (22 years) β Bismuth-210 (5.01 days) β Polonium-210 (138.4 days) α **Lead-206** **(Stable isotope)**	↓	Thorium-232 (1.39×10^{10} years) α Radium-228 (6.7 years) β Actinium-228 (6.13 hours) β Thorium-228 (1.90 years) α Radium-224 (3.64 days) α Radon-220 (54.5 seconds) α Polonium-216 (0.158 seconds) α Lead-212 (10.6 hours) β Bismuth-212 (60.6 minutes) α Thallium-208 Polonium-212 (3.1 minutes) (3.0×10^{-7} seconds) β α **Lead-208** **(Stable isotope)**
Potassium-40 decays via β emission or electron capture to stable end products, calcium-40 and argon-40, and has a half-life of 1.27×10^9 years. Potassium-40 constitutes 0.012 percent of potassium isotopes. Uranium-235 decays via decay chain to the stable end product, lead-207, and has a half-life of 7.13×10^8 years. Uranium-235 constitutes 0.7205 percent of natural uranium isotopes.		

Note:

a Some extremely short-lived or minority isotopes of the decay chains have been omitted here for brevity. For more detailed information, see Friedlander and others (1964).

Specific analysis of potassium-40 is needed to evaluate whether this isotope is contributing to the gross beta activities measured in groundwater samples from HPS. Because of the possibility that salt water intrudes into near-shore groundwater, understanding the extent of this naturally occurring beta-emitter in local groundwater is critical to any assessment of data for gross beta activity. It will not be possible to eliminate the beta input from naturally occurring potassium-40.

Radium

Radium is an alkaline-earth metal that behaves geochemically much like barium. There are four naturally occurring isotopes of radium (223, 224, 226, and 228). Radium-painted dials and gauges stripped from ships are known to have been disposed of at HPS and contain the 226 isotope. No fractionation of these isotopes should occur naturally during weathering of minerals or transport of groundwater.

Radium-painted dials and gauges removed from ships being refitted were disposed of separately from scrap metal; however, some were not separated from the metal before disposal in pits, trenches, and landfills at HPS.

Radium-226

Radium-226 occurs naturally as part of the uranium-238 decay series. It is an intermediate-lived (half-life equal to 1,622 years), alpha-emitting radionuclide. Myrick and others (1983) estimated a nationwide background level of 1.1 picocuries per gram (pCi/g) in surface soils. Most water contains less than 1.0 pCi/L total radium, but activities of radium-226 that exceed 100 pCi/L have been reported for deep waters in uranium-rich rocks (Hem 1992).

Existing data for groundwater samples collected from HPS indicate that radium-226 is present in groundwater at activities as high as 3.21 pCi/L; however, background levels have not been established. Gross alpha activities as high as 94 pCi/L were reported for samples collected in 2001 from wells in Parcel E; however, radium-226 activity does not correlate with gross alpha activity for these samples (Figure 4-2 in Appendix 4). The lack of correlation may mean that a different alpha-emitting radionuclide is responsible for the gross alpha activities observed.

Radium-228

Radium-228 is the first product in the thorium-232 decay series. It is a naturally occurring, short-lived (half-life = 6.7 years), beta-emitting isotope.

Existing data for groundwater samples collected from HPS indicate that radium-228 is present in groundwater at activities as high as 3.15 pCi/L; however, background levels have not been established. Gross beta activities as high as 241 pCi/L were reported for samples collected in 2001 from wells in Parcel E; however, radium-228 activity does not correlate with gross beta activity for these samples (Figure 4-2 in Appendix 4). This lack of correlation suggests that another beta-emitting radionuclide is responsible for the high levels reported for gross beta activity.

Tritium

Tritium, 3H, is the radioactive isotope of hydrogen and has a half-life of 12.43 years. A small amount of tritium forms naturally, but the main historical source of tritium in precipitation is fallout from aboveground testing of nuclear weapons. Atmospheric tritium reached a peak in 1963 and 1964, after nuclear tests. During these peak years, average annual fallout values exceeded several thousand tritium units (TU) (one atom of 3H per 1,018 atoms of 1H). One TU is equivalent to 3.193 pCi/L.

The tritium content of groundwater recharged before 1952 should be about 1.3 TUs based on an assumed natural content of 10 to 15 TUs in pre-bomb precipitation and adjusted for radioactive decay. Tritium is generally analyzed by liquid scintillation counter (U.S. Department of Energy 1995). Because tritium was used at HPS as a target for accelerators (Building 816) and was present in radioactive wastes stored at Building 529, selected wells will be sampled for analysis of tritium.

Uranium

Uranium exists in two valence states (+4 and +6) and is quite soluble in alkaline, oxidizing environments, or when complexed with carbonate. Natural uranium is composed primarily of the uranium-238 isotope, with lesser amounts of uranium-235 and uranium-234/233 (the 233 and 234 isotopes are not resolved by the analytical method used). Uranium-235 is the fissionable isotope used in nuclear weapons and as fuel for power plants.

Uranium-234, -235, and -238 are naturally occurring alpha-emitting radionuclides whose presence may contribute to the gross alpha activities measured in groundwater at HPS. Data for these uranium isotopes are needed to evaluate whether they are naturally producing the gross alpha activities observed in groundwater at HPS.

Uranium-234

Uranium-234 constitutes only 0.0057 percent (by weight) of natural uranium. Formed as an intermediate product in the naturally occurring uranium-238 decay series, uranium-234 is a long-lived (half-life equal to 2.48×10^5 years), alpha-emitting radionuclide.

Uranium-235

Uranium-235 is a naturally occurring, very long-lived (half-life equal to 7.13×10^8 years) radionuclide. It, like plutonium-239, is capable of sustained fission reaction. However, uranium-235 constitutes only 0.72 percent of natural uranium; therefore, mined uranium requires refining and subsequent enrichment to provide adequate amounts of the 235 isotope for fuel or weapons. Lead-207 is the stable end product of the uranium-235 decay chain.

Uranium-238

The uranium-238 isotope constitutes the bulk (99.9 percent by weight) of all naturally occurring uranium isotopes. It is a long-lived (half-life equal to 4.51×10^9 years), alpha-emitting radionuclide, producing lead-206 as the stable end product of its decay chain (Table 5-1). Background activities of uranium-238 lie in the range of 0.2 to 3.7 pCi/g for surface soils in the United States (Myrick and others 1983).

1.3 ANTHROPOGENIC RADIONUCLIDES

Since the advent of the Atomic Age, anthropogenic radionuclides have been distributed worldwide and have created an anthropogenic background level. Among others, these radionuclides include americium-241, cesium-137, cobalt-60, strontium-90, and plutonium species that are typically referred to as “fallout radionuclides.”

Americium-241

Nuclear weapons explosions produce only small amounts of americium-241, which has a half-life of 438 years, and much larger amounts of plutonium-241, which decays by beta emission to americium-241. A small amount of americium-241, as well as plutonium isotopes, was produced by aboveground nuclear weapons testing and was distributed worldwide, resulting in a mean anthropogenic background activity of approximately 0.01 pCi/g in surface soils (U.S. Department of Energy 1995).

The Naval Radiological Defense Laboratory (NRDL), which was formerly housed at HPS, had a license from the Atomic Energy Commission (later called the Nuclear Regulatory Commission) for obtaining and handling special nuclear materials, including americium. There is no record of any release of americium-241 at HPS. Because its solubility is limited in neutral pH waters under atmospheric conditions, little americium is expected in groundwater at HPS as a result of fallout or site-related activities.

Cesium-137

Cesium-137 is a relatively short-lived (half-life equal to 30 years) beta emitter produced by fission reactions and is distributed worldwide through fallout from aboveground nuclear weapons testing. It is an alkali metal that is taken up by vegetation or is strongly bound to soils. Erosional processes tend to redistribute cesium-137 in the terrestrial environment, removing it from erosional areas and concentrating it in depositional areas. Because its solubility is limited in neutral pH waters under atmospheric conditions, little cesium is expected in groundwater at HPS.

Cobalt-60

Cobalt-60 is a short-lived (half-life equal to 5.26 years) beta emitter formed by nuclear fission reactions. It was distributed worldwide by aboveground nuclear weapons testing, but is primarily produced in nuclear reactors. Cobalt-60 is used as sealed sources in industrial radiography, check sources in radiation detection instruments, and other minor uses in electronic equipment.

Sources of cobalt-60 were housed and used at the NRDL, although no releases were documented. Total concentrations of cobalt (that is, radiogenic and nonradiogenic isotopes) in most waters are less than 1 microgram per liter (Hem 1992), but this element may form complex ions that increase the apparent solubility of the metal. Based on the history at HPS and the geochemical behavior of cobalt, detectable activities of cobalt-60 in groundwater are not considered likely.

Strontium-90

Strontium-90 is a strong beta emitter with a half-life of 29 years, and is considered one of the more undesirable of the fission products found in fallout (Friedlander and others 1964; Hem 1992). Because the geochemical behavior of this element is similar to calcium, it, like radium, can mineralize into bone tissue if ingested.

Specific analysis of strontium-90 is needed to evaluate whether this isotope is contributing to the gross beta activities measured in groundwater samples from HPS.

1.4 RADIOLOGIC INDICATORS

Gross Alpha

Gross alpha is considered an indicator of radionuclides and is not itself a radionuclide. Rather, gross alpha activity reflects the sum of alpha-emitting radionuclides. Radium-226 and radon are the primary alpha-emitting species in natural waters (Hem 1992).

Gross Beta

Gross beta is also a measurement that indicates the presence of beta-emitting radionuclides. Potassium-40 is a beta emitter that averages 300 pCi/L in sea water. In addition, many of the fallout radionuclides, such as strontium-90, are strong beta emitters. Radium-228 is also a beta emitter.

2.0 IDENTIFICATION OF POTENTIAL SOURCES OF RADIOACTIVITY IN GROUNDWATER

As discussed previously, the geochemical behavior of various radionuclides influences their mobility and likely occurrence. Because isotopic fractionation by natural chemical and physical processes is generally restricted to elements with low (less than about mass 40) atomic numbers (Faure 1986), isotopes of the same high-atomic-weight element should exhibit the same geochemical behavior. Therefore, heavy elements such as strontium, radium, uranium, plutonium, cesium, americium, and thorium suffer no natural fractionation of their isotopes under conditions at the surface of the earth.

Elements that tend to be soluble in oxidizing, neutral pH conditions include potassium, strontium, radium, and uranium; isotopes of these elements may therefore be expected as dissolved constituents in groundwater. Conversely, cesium, plutonium, and americium tend to be strongly sorbed to soils, so their presence in groundwater is unlikely except under extreme conditions of redox potential and pH. Knowledge of expected geochemical behavior, along with institutional knowledge of site activities, allows a more refined selection of the radionuclides to be analyzed in groundwater samples.

Because data for radionuclides are treated differently than data for metals in the statistical analysis, summary statistics will be reported for all isotopes, regardless of the reported detection rate; however, minimum detectable relative differences will be calculated only for those radionuclide species qualified to exhibit detection rates greater than 50 percent.

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4.0 GLOSSARY

Fractionation is a process that separates different compounds or isotopes from other compounds or isotopes as a result of slight differences in physical (for example, atomic weight) or chemical properties.

Isotopes are atoms that have the same atomic number, but differ in atomic weight because of a different number of neutrons.

pH is the negative logarithm of the hydrogen ion activity; usually taken as a measure of how acidic or basic a solution is.

Radionuclides are isotopes of elements that are characterized by the release of energy and energetic particles by changes occurring within the atomic or nuclear structure.

Redox potential (Eh) is defined as the oxidation-reduction potential, which provides a measure of the availability of electrons or the potential (in volts) of the half-cell against a standard hydrogen half cell. Basically, a low Eh indicates a reducing environment, such as a swamp, whereas oxygenated environments have a higher Eh (measured in volts).